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NOVEMBER • 1944

649: Journal Section of the American Society of Heating and Ventilating Engineers

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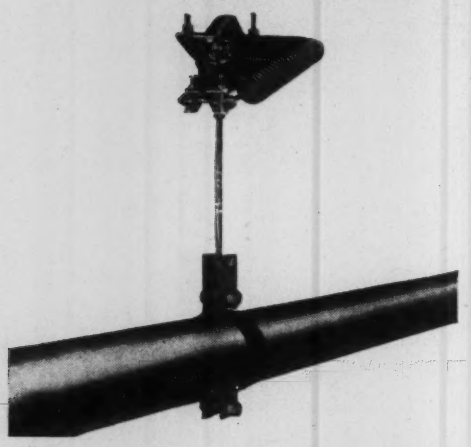
Pre-Engineered SUSPENSION



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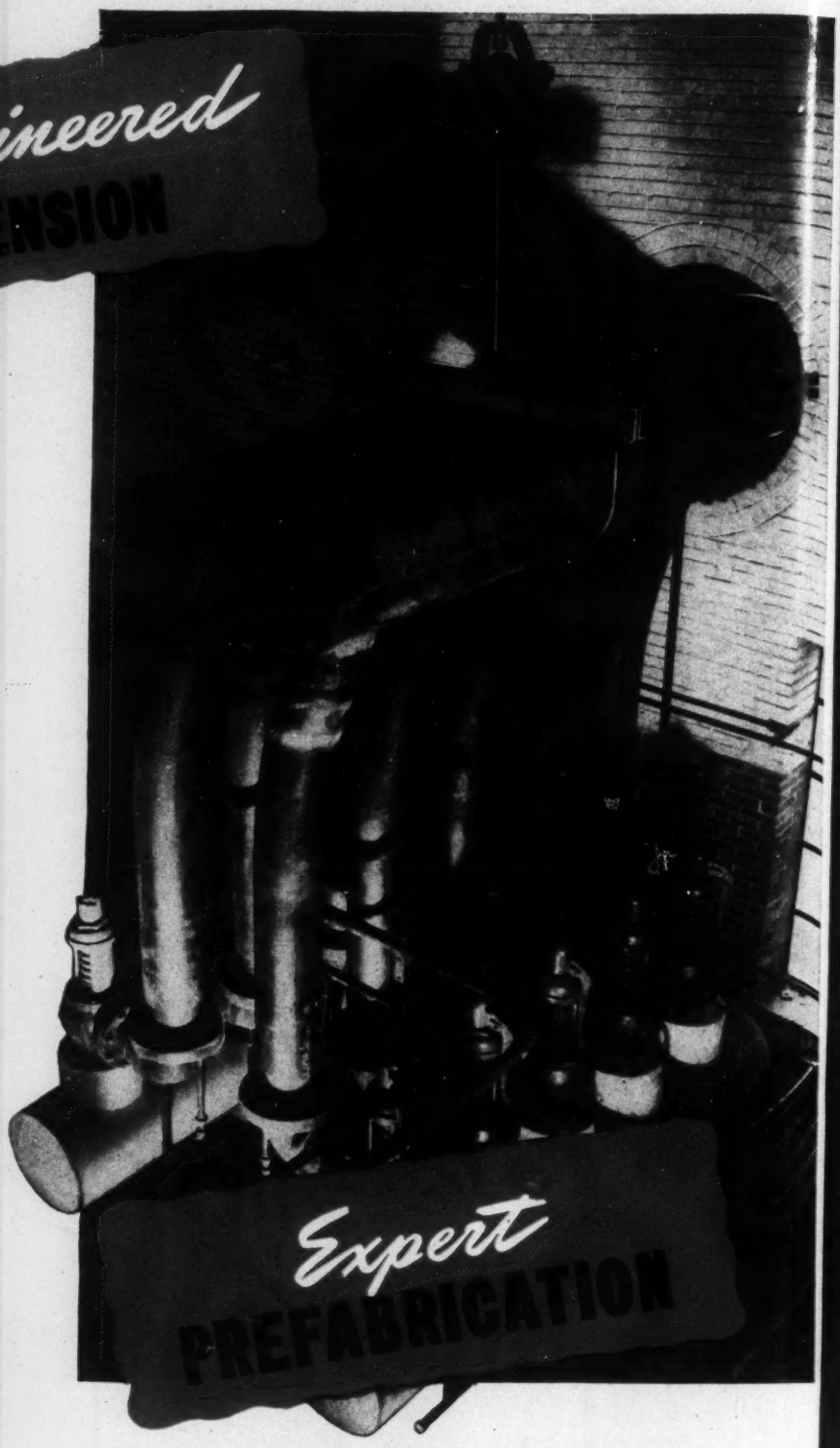

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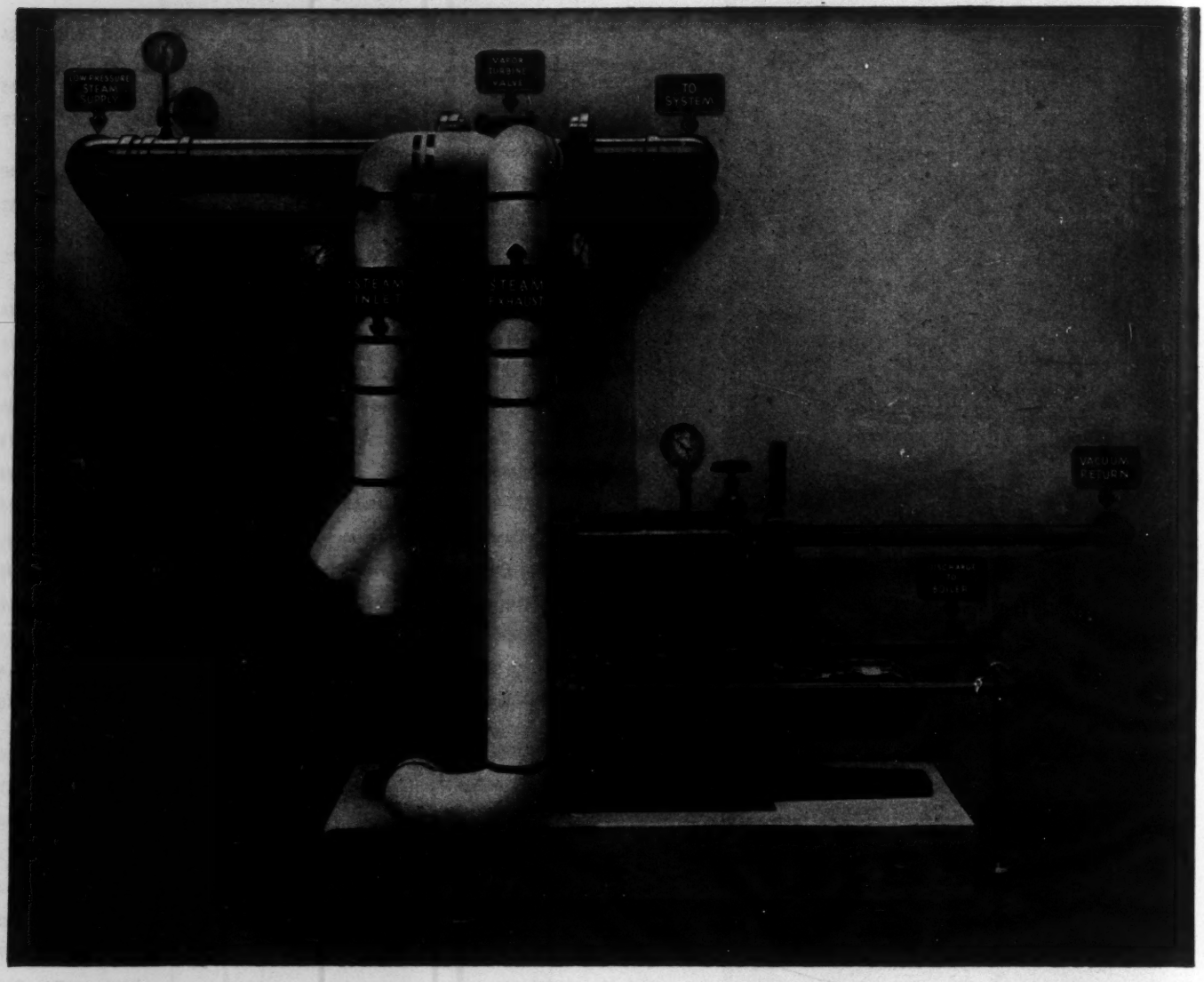
Interrupted Electric Service will not stop this NASH Heating Pump!



In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is independent of electric current failure, and continues to operate as long as there is steam in the system.

This is because the prime motive power of this economical pump is a special steam turbine, controlled by a unique "Vapor Turbine Valve", which automatically bypasses from the heating main a small portion of steam, the exact amount necessary to develop the power needed to remove the condensate and maintain the required vacuum on the system. Even this small amount is passed immediately back to the mains, and goes on to the system with little heat loss. This pump operates on any system, high or low pressure.

The Vapor Turbine is a most economical pump, for the elimination of electric current does away with current cost, the largest single item in the operation of an ordinary return line heating pump. Bulletin on request.

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AIR CONDITIONING ESSENTIAL SERVICE FOR RADAR, ELECTRONICS LABORATORY

Development of This Important War and Postwar Apparatus Depends Upon Controlled Temperatures and Humidities, Says H. C. Hoffmann

Through the use of air conditioning for process requirements in its new research and development laboratory, the Rauland Corp. joins the ever-increasing list of companies which have found controlled temperatures, humidities, air cleanliness, etc., essential in the overall industrial picture of efficient design, research, and manufacture. The rapid acceleration of industrial advance and achievement caused by the war has emphasized in this industry—as in many others—the need for constant control of atmospheric conditions. A strong trend for an even broader application of industrial air conditioning on a large scale during the postwar years is indicated by the wartime record, says Mr. Hoffmann, application engineer, the Carrier Corp.

* * * * * *

RADAR AND ELECTRONICS in general are widely recognized as important contributions to the success of the armed forces of the United Nations. Much, too, is expected of these developments during the postwar years. The application of the sciences now employed for war pursuits should be of great assistance in arriving at solutions of many problems encountered in time of peace. Until the lid may be lifted, however, the details of the scientific progress which has been made must remain unknown to the general engineering public.

The Rauland Corp., Chicago, has recently completed an extension to its present plant facilities housing a complete and modern research and development laboratory for work in electronics and radar. The elimination of dust and noise and the need for controlled temperatures and humidities for test and process work makes air conditioning essential for all seasons of the year. It is one more example of air conditioning as a vital part of industrial accomplishment. The application of air conditioning to this building posed a number of interesting problems.

In keeping with the architectural design for many types of industrial laboratories, the extension is a windowless, one story building. The general building plan and the details of lighting and arrangement of spaces were closely supervised by E. M. Rauland, the company's president, and J. A. Kreutzer, its vice-president, who made certain that the needs of the processes and technicians were met fully and completely. A continuous 5 ft high band of glass block in the exterior walls affords ample light to those areas adjacent to this outside exposure and, in addition, serves to create a pleasing horizontal line, architecturally speaking.

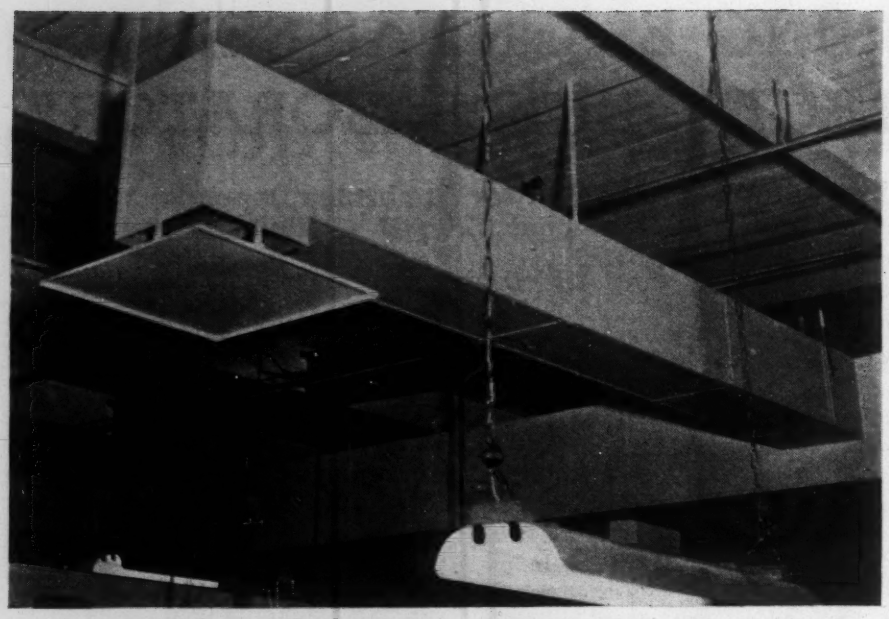
The building is approximately 100 ft by 150 ft and is divided into two main types of rooms; one of these is a large interior "work space" section, and the other consists of 22 individual laboratory rooms, each serving as a special research area and technical office space combined.

Also in keeping with present trends for air conditioned buildings, fluorescent lighting was chosen and is used throughout. Hung ceilings of sound deadening type construction were installed in the individual laboratory sections and increase the effectiveness of the sound isolation resulting from the windowless construction. The overall effect is an extremely low sound level, an obvious asset for research work.

Bypass System for Work Space, Reheat for Small Laboratories

Along with other problems faced in the air conditioning of this building under wartime restrictions was the normal and customary problem of providing proper zoning for all of the various spaces and the choice of control for each zone commensurate with the

Finned tube radiation meets the wall and roof losses and gives adequate coverage of the glass block strip



Wartime restrictions on sheet metal led to the choice of asbestos cement board for ductwork

Some of the radiation for meeting wall and roof losses may be seen in this view of the corner laboratory room

particular requirements of accuracy. A combination of all zones on a central station apparatus was indicated as most desirable both by the size of the overall cooling load (80 tons) and space considerations, as well as the limitations imposed by the practical economics of design.

On first glance, the building looked as if three basically different zones were involved: (1) the large open internal work space area; (2) the laboratories without outside exposure (except roof); and (3) the laboratories with exterior walls involving variable sun exposure and transmission gains and losses. However, on analysis, the three zones were not the answer. From a control accuracy and process requirement standpoint, the standard conception of bypass temperature control for summer operation was perfectly satisfactory for the work space. Because of the great variations in loads between individual laboratories due to differences in electrical equipment, people, and other sources of heat gain, a single central system was installed to serve all individual laboratories, with control for these spaces by reheat with separate steam booster coils installed in the supply ducts to each laboratory.

The continuous strip of glass block in the exterior walls created a heating problem because cold air would fall off this surface, resulting in objectionable drafts, if all of the heating were done with air. The most satisfactory solution seemed to be a split system employing air conditioning and finned tube radiation similar to that used in railway car heating systems. The finned surface was sized to provide adequate heating for wall and roof losses and gives adequate coverage of the glass block by extending along the outside wall for practically the entire width of each room. Control of this surface was tied in with the room thermostat, as described later.

While a direct expansion central station dehumidifier would have been the normal choice for a plant of this size, it could not be considered for this application because of the wartime restrictions on the use of "Freon-12." In its stead, an indirect system employing methyl chloride to chill water was used as the cooling medium.

Wartime limitations on the use of sheet metal for air distribution purposes led to the choice of asbestos cement board for ductwork and apparatus casings. Sheet metal was used only where required for corner joints, unusual fittings, and for stiffening purposes. In addition, sheet metal was used to construct the pan type outlets used throughout the installation.

Both the air handling and re-

frigeration equipment were placed in a penthouse.

One nonfreeze steam preheater coil, an electrostatic air cleaner, and a spray coil dehumidifier serve both air conditioning systems. After leaving the dehumidifier the air is divided, part entering one fan and the remainder the other fan. The fan serving the work space system has a capacity of 14,750 cfm, while that for the laboratory area handles 13,020 cfm. Each fan is driven by a 7½ hp motor, and each fan has its own set of steam reheater coils at the inlet of the fan. A split sheet serves to divide the spray coil dehumidifier with respect to the fans. The electrostatic type of air cleaner was chosen because of the need for a high degree of air cleanliness due to the nature of the operations in the manufacture of cathode ray tubes, and the research in connection with radar and radio.

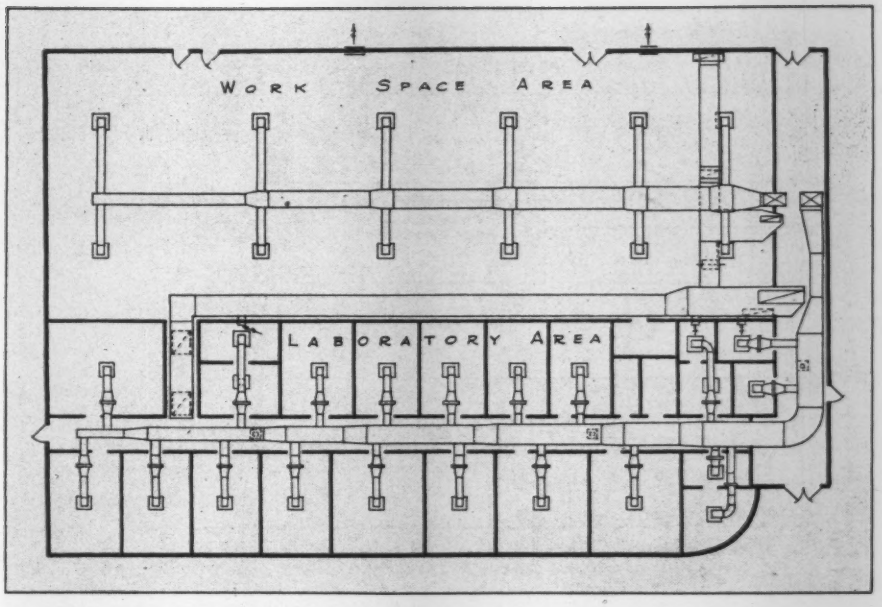
The need for close control during all seasons of the year, and under all degrees of exposure, required that provision be made for wide variations in refrigerating capacity. To this end, four equal size reciprocating compressors are used, each driven by a 25 hp motor, thus affording steps of 25, 50, 75, and 100 per cent of full load. The compressors are interconnected and mounted on a common isolation base, and are served by a common condenser which (for space saving purposes) is racked above the dry expansion cooler. A close coupled pump driven by a 5 hp motor furnishes chilled water from the refrigerating system to the dehumidifier coils. A ½ hp recirculating spray water pump, also close coupled, provides humidification in winter and cold spray in addition to the cooling coils during other seasons.

The necessity for confining the penthouse to the size of one bay created a problem. Careful consideration of the apparatus layout was a "must" in order to fit all of the equipment required for proper operation into the limited space allowed.

How Temperature Is Controlled

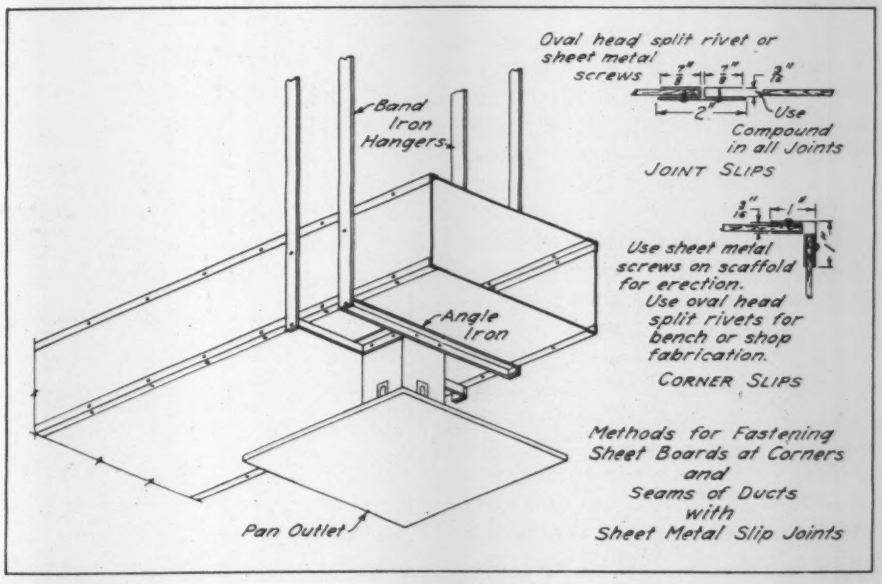
A pneumatic system of temperature control is used. The central station dehumidifier control is arranged by interconnecting electrical relays so that the minimum outside air damper opens whenever either of the two main fans is started. Dew point control in the summer season is obtained by a three way mixing valve on the chilled water to the cooling coils. During the winter the dew point thermostat controls steam flow to the nonfreeze steam preheaters by means of two modulating steam valves which operate in a sequence action, depending upon the steam requirements. To provide flexibility, a switch was installed so that the operator may place the maximum outside air and return air dampers in the "closed" or "open" positions, or he may throw the operation of these dampers on automatic floating control at the command of the dew point thermostat. To avoid wasting steam, the preheater valves are automatically closed by main control air pressure whenever the fans are shut down.

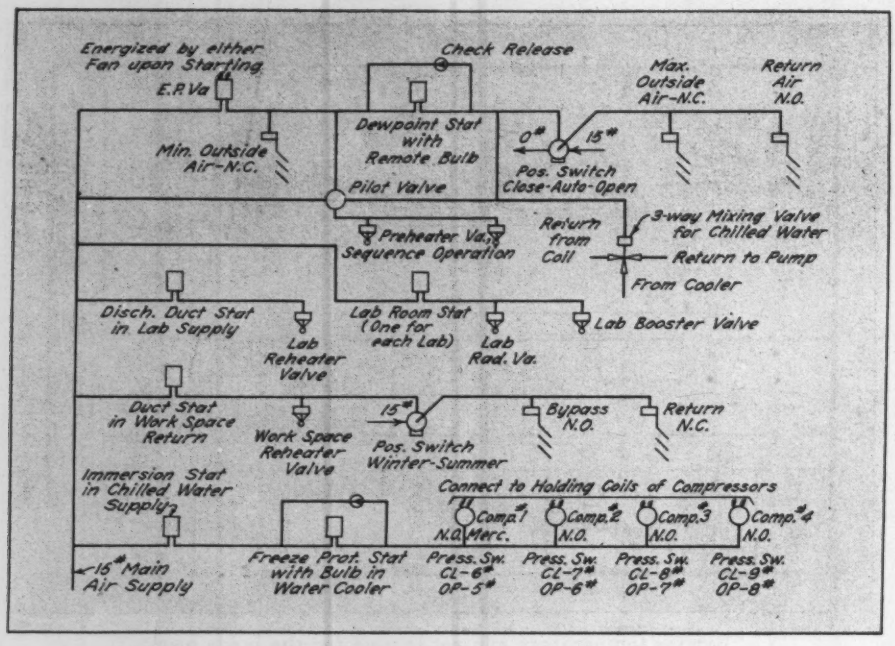
Temperature control in the individual laboratories is effected by room thermostats which control the individual steam booster coils in the branch ducts. In the case of



Bypass temperature control is used for the large work area and control for the laboratory rooms is by reheat

Sheet metal was used where required for corner joints, unusual fittings, for stiffening purposes for ducts, and to construct the pan type outlets


Oval head split rivet or sheet metal screws
Band Iron Hangers
2"
Use Compound in all Joints
JOINT SLIPS
Use sheet metal screws on scaffold for erection.
Use oval head split rivets for bench or shop fabrication.
CORNER SLIPS
Angle Iron
Pan Outlet
Methods for Fastening Sheet Boards at Corners and Seams of Ducts with Sheet Metal Slip Joints



Schematic control diagram for the air conditioning system

rooms with outside exposures, the radiation is also controlled by this thermostat, in sequence with the booster coil, so that the radiation receives steam first to provide heat for the wall surfaces. A duct thermostat in the discharge of the main fan provides winter low limit temperature control for the entire laboratory system, and thus eliminates drafts due to low delivery air temperatures.

For the work space area, a return air duct thermostat furnishes bypass control of temperature during the cooling season through a summer-winter switch. Winter control is obtained by closing this bypass and modulating the flow of steam to the main reheater coils at the fan inlet.

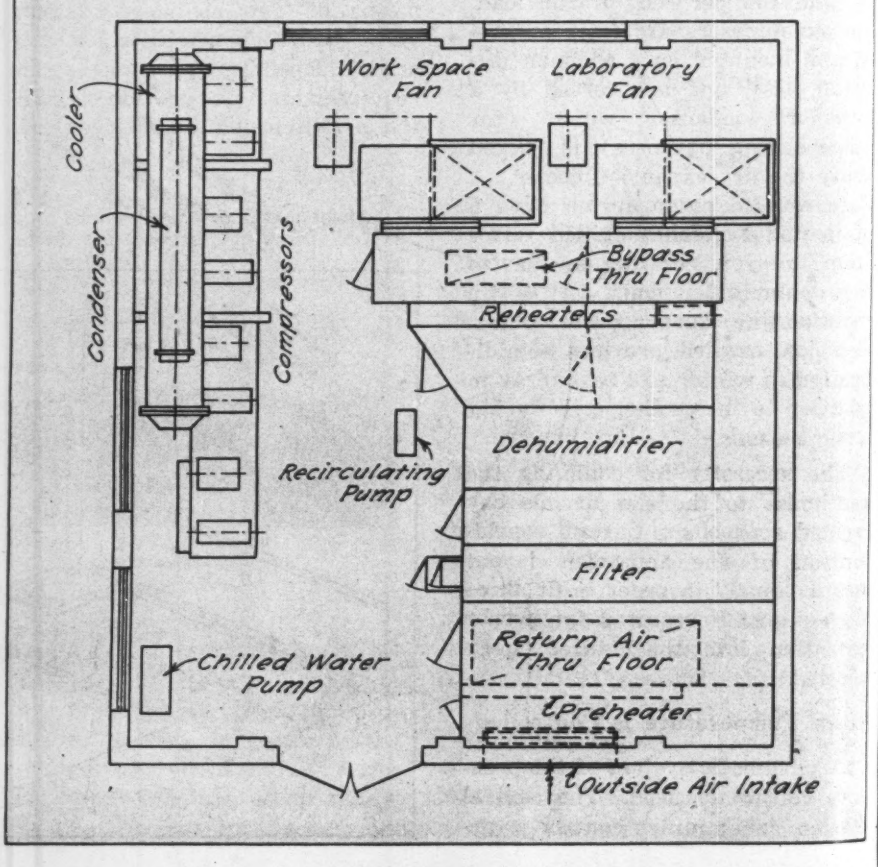
Refrigeration capacity reduction is controlled through four mercury switches which make or break the holding coil circuits of the individual compressor starters, depending upon the branch air pressure from the water immersion thermostat in the main chilled water line leaving the cooler. The thermostat thus maintains a constant temperature chilled water supply by operating these mercury switches through a freeze protection thermostat which has its bulb in the cooler. In the event that the chilled water temperature drops to or below 38 F because of faulty operation or immersion thermostat failure, the freeze protection thermostat causes a complete shutdown of all refrigeration.

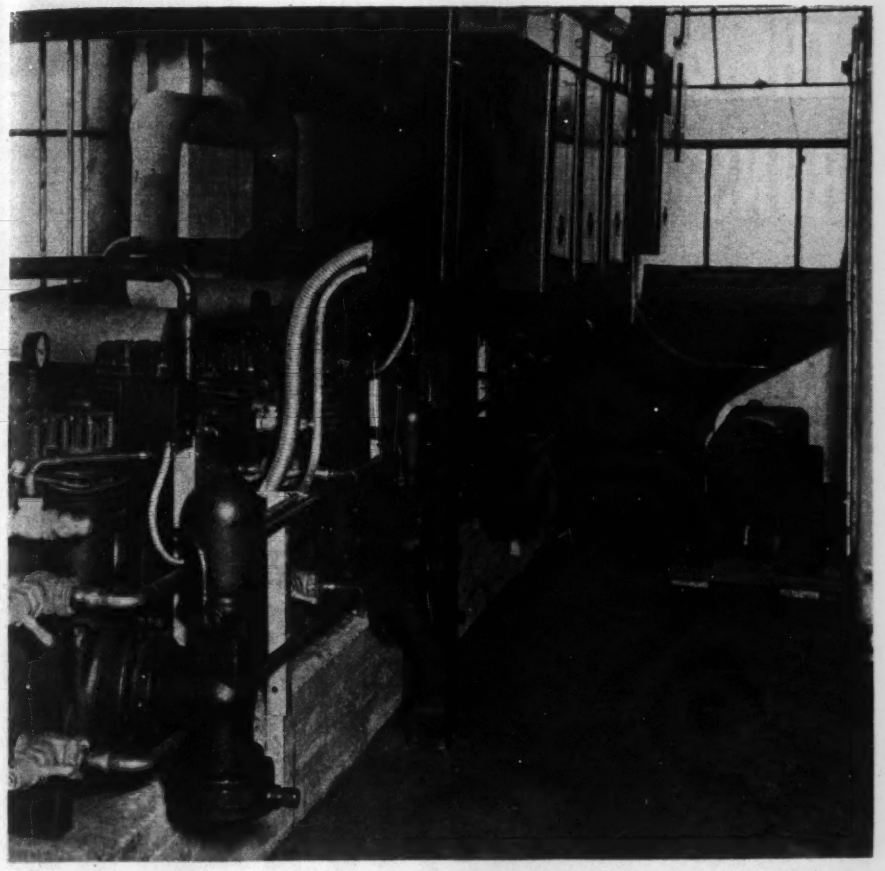
The mercury switches are set for sequence operation of the compressors, with sufficient pressure differentials between steps to avoid excessive cycling of the machines. Even operating usage on the compressors is obtained by periodic resetting of the operating control pressure of the respective switches or, more to be preferred, by throwing the disconnect switch to remove one compressor from the line. The latter method may be used at all times except during peak load operation and avoids the difficulties involved by the resetting and recalibration method. In this manner each compressor serves an equal period in each of the four positions of the cycle, which naturally vary greatly in service hours.

Cathode Tube Coating a Delicate Process

In connection with the work space area, and adjoining it, is a separate cathode ray tube screening process room 30 ft long by 12 ft wide, for which a separate air conditioning system was installed to maintain conditions at 72 F and 50 per cent relative humidity. The delicate process of coating the cathode ray tubes is performed in this room and requires close control of humidity and extreme cleanliness. To accomplish the latter,

Necessity for confining the equipment penthouse to the size of a building bay made careful consideration of the layout a "must"





Four reciprocating compressors are used to give steps of 25, 50, 75, and 100 per cent of full load

electrically filtered air is obtained from the main system for ventilation purposes and this is refiltered, together with return air, through four cells of throwaway filtering pads.

Close Control

Close control of dry bulb and humidity is effected by opposing heat and refrigeration by a very complete but simple pneumatic control system. Compressor operation is controlled by either the room hygrostat or thermostat, or both, while the steam reheater coil is at the command of the room thermostat only—all by means of pressure electric switches.

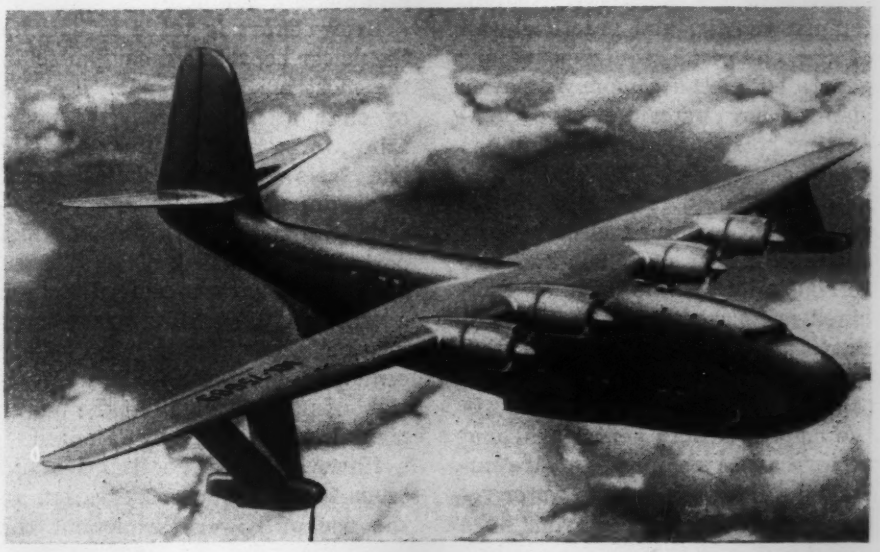
The Rauland plant was designed and built by the Clearing Industrial District, Inc. Subcontractors on the air conditioning work included Narowetz Heating & Ventilating Co. for the ductwork and apparatus casings; Air Comfort, Inc., for the installation of the refrigeration cycle; and James H. McCauley & Sons for the steam piping and direct radiation.

HEATING AND VENTILATING BIG JRM-1 AIRPLANE

The heating and ventilating system of the JRM-1 airplane—the production version of the Glenn L. Martin Co. "Mars" illustrated here—is made up in two sections, a heating system for the flight deck and the forward compartments and a ventilating system for the aft compartments.

The heating system for the forward compartments consists of two combustion type heaters rated at 100,000 Btu output each. These heaters supply the flight deck, the galley, the baggage compartment, and the lower forward deck with heat and fresh air. The heaters are situated on the flight deck convenient for servicing and maintenance. Fuel for the heaters is obtained from the ship's service tank. Ventilating air to the heaters is supplied through outside ram air scoops and the air flows through the heaters where it is either heated if required or distributed by ducts to the various compartments. One heater is equipped with a motor blower unit to supply ventilating and combustion air while the ship is afloat or on the ground. The flight deck is soundproofed and insulated to reduce the heat loss and noise level to a minimum. Ducts are provided to lead hot air to the windshield and also to a foot warmer for the pilots.

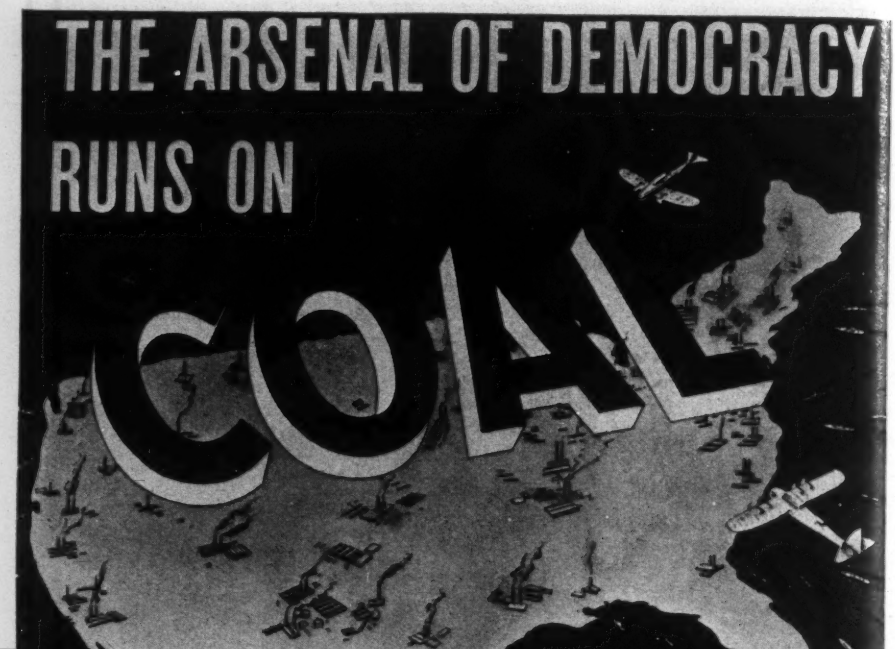
The upper and lower after decks are provided with ventilation only. Three ram air intake scoops are provided at the upper deck for ventilation. The air for the lower deck is distributed through ducts to supply fresh air near the seat and bunk provisions. The rate of ventilation can be adjusted by operating manual dampers at the intake scoops. Exhaust grilles are provided at the aft end of the lower deck, adding to the ventilating quality of the system.



RECOGNIZING THE serious coal shortage with which the country was faced and desiring to cooperate in every possible way with the national conservation program, the Eastman Kodak Co. inaugurated an intensive, organized fuel saving campaign in October 1943.

From the start of the campaign on October 19, 1943, until September 1, 1944, the overall plant production increased 5.6 per cent over the same period in the preceding year when there was no organized fuel saving campaign. In spite of this production increase, the coal consumption has decreased 1.6 per cent in this period. Actually, 3566 tons less coal were burned than in the same period in the preceding year. This is a substantial saving, and while it may not all be due to the fuel saving campaign because of the many factors involved in a plant of this size, there is no doubt that the campaign has played the major part in effecting the accomplishment. It is also a real contribution to the national fuel conservation program and the war effort. All the campaign workers have been commended on the splendid results obtained.

The entire plant has become fuel saving conscious and aware of the fact that every economy that is made in the use of power services means a reduction in coal consumption. Over 90 per cent of the power services are metered to the individual departments so they have a measure of the results obtained in the department.



Efficiencies Up to 84 Per Cent

All of the steam, refrigeration, compressed air, and practically all of the electrical requirements are generated in the company's power plants. Two steam-electric generating plants have a combined steam capacity of 1,105,000 lb per hr at pressures ranging up to 820 psi, and a combined electric generating capacity of 24,800 kw. Two refrigeration plants have a combined rated capacity of 15,000 tons. Based on pre-war information, this is one of the largest single interconnected refrigeration plants in the country. Both centrifugal and reciprocating compressors are installed. All of the service water requirements are pumped from Lake Ontario, approximately six miles from Kodak Park. The total capacity of the waterworks is 25 million gallons per day. The installed air compressor capacity is 11,000 cfm. The entire plant consists of 95 buildings, occupying an area of approximately 241 acres.

Every effort is made to operate the power department equipment in the most efficient manner possible by close attention from the operating force and continuous study and tests by the technical staff. The equipment is kept in good condition by frequent inspections and periodic overhauls. The 820 psi boiler plant with underfeed stokers operates with yearly average combustion efficiencies up to 84 per cent. The prospects for any appreciable further savings in the power plant itself seemed quite limited.

However, good possibilities did seem to exist for conservation in the use of power throughout the manufacturing departments, and the campaign was organized on this basis. A general plant fuel saving committee was appointed by the management to work with departmental supervision. The committee consists of a mechanical engineer, an electrical engineer, a maintenance engineer, and a power engineer, and it is responsible for the general organization and running of the campaign. Each department head has appointed a department fuel saving supervisor, who is responsible for administering the campaign in his department. Fuel saving committees have been appointed for each department with sufficient assistants so that someone is responsible in every part of the department for keeping a continuous watch on all power services to reduce their use to the minimum required to maintain production and safety and to eliminate waste. Departments are carrying on the

campaign through direct contact with the employees, periodic foremen's meetings and department committee meetings, departmental bulletins, and urging the use of the plant's suggestion system, which provides substantial money awards for good ideas. Some conception of the size of the campaign organization can be obtained from the fact that 41 department fuel saving supervisors have been appointed.

In addition to the departmental organizations, the plant is divided into sections, and the general committee appointed a subcommittee for each section to make a detailed power economy inspection of all departments in the section. The subcommittee consists of the department fuel saving supervisor, a mechanical engineer, an electrical engineer, and a maintenance engineer familiar with the department.

On inspections, every use of steam, electricity, water, compressed air, gas, and refrigeration in the department is studied in detail with particular attention given to large power-consuming processes. The department fuel saving supervisor acts as secretary for the subcommittee and keeps a record of the recommendations made, prepares the inspection report, places necessary work orders, and is responsible for seeing that all recommendations are acted on promptly by the department supervision and put into effect as quickly as possible. Economies are made as far as is practical with present equipment and facilities.

Bulletins and Publicity Stress Importance

For the use of the campaign workers, bulletins have been prepared on the coal consumption of the various services and leaks, as well as on suggestions for the elimination of waste and the conservation of services. In the latter bulletin, 23 detailed suggestions are given on steam, 15 on electricity, 10 on refrigeration, 10 on compressed air, and five on water. These suggestions were published in the April 1944 issue of HPAC.

General plant publicity has been given the campaign through the use of a continuous series of fuel and power conservation posters on the 153 general plant news boards, notices on pay envelopes, and articles in the plant magazine. The posters are left on the general news boards for one week and then used on departmental bulletin boards. Departments are also posting bulletins from time to time on their own bulletin boards, calling attention to detailed methods of conservation peculiar to the department. No suitable posters tying in the campaign to the war effort could be purchased, so a series has been designed and produced by the company organization. One of the posters is shown in the accompanying illustration.

Throughout the publicity, the importance of the campaign to the war effort and the seriousness of the coal shortage are being stressed in every possible way. Special emphasis is placed on the fact that the biggest saving can be made by continuous watching and economies by every employee in the day-by-day use of power services, such as shutting off steam when not needed and keeping room temperatures normal, turning off unneeded lights and idle motors, stopping waste of water, refrigeration and compressed air, and promptly reporting leaks.

920 Fuel Saving Suggestions from Department Inspections

Outside of a few small exceptions, practically every building and department of the plant has been given a detailed inspection by the subcommittees. As a result of these inspections, 920 fuel saving recommendations have been submitted—which is ample evidence of the thorough job that has been done. In addition to this, many departments have their own committees making regular inspections and many excellent recommendations are being made.

Throughout the campaign, too, employees have been urged to use the plant suggestion system, which provides money awards for good ideas. The results have been gratifying, and since the start of the campaign 98 worthwhile suggestions on fuel saving have been received. The highest award paid was $500 for a suggestion which is saving about two million gallons of water a month regularly. The average award paid was a little over $21 per suggestion.

Others Use Similar Conservation Campaigns

The Kodak fuel saving campaign plan is being widely used throughout the country as a pattern for similar conservation efforts. The Rochester ordnance district has campaigns underway in a large number of plants using our company plan as a basis. The national fuel efficiency program of the U. S. Department of the Interior, Bureau of Mines, has had a large number of copies of the plan distributed throughout the country to show the accomplishment of one particular industry. All of our company branches have similar campaigns under way.

The national coal situation is still critical, and the Eastman campaign is being and will continue to be vigorously carried on.

From a national standpoint, large savings can undoubtedly be made by increased efficiency in the operation of industrial power plants. Great possibilities would also seem to exist in the vast and probably scarcely-touched field of economy in the use of power and heating services. Intensive, organized campaigns for this purpose should go a long way toward relieving the coal shortage and insuring an ample coal supply for our war production program and ultimate victory.

HOW FUEL IS SAVED

Oscar V. Sprague, engineer in charge of power operation of the Eastman Kodak Co.'s Kodak Park works, describes here the fuel saving campaign which has played the major part in a 1.6 per cent decrease in coal consumption despite an increase of 5.6 per cent in overall plant production. Nine hundred and twenty fuel saving recommendations resulted from detailed department inspections, and 98 worthwhile suggestions were made through the Eastman plant suggestion system, one of which is saving two million gallons of water a month regularly.

Earle Shultz, Manager of the Edison and Marquette Buildings, Says That by Turning On Steam Later and Shutting It Off Earlier Office Buildings Can Meet Wartime Fuel Shortages Better Than by Reducing the Temperature Inside Throughout the Day; Data on His Two Buildings Show Savings of 18.6 and 21 Per Cent

Save Steam by Short Hour Heating

OFFICE BUILDINGS, as a group, are probably efficiently operated, and it is possible that the additional savings still to be obtained may not accomplish the reduction in fuel used that the government considers necessary for this winter. In that case, doubtless some form of definite limitation in the amount of fuel used can be resorted to. Such limitation can be made in one of two ways:

The first is to cut down the amount of heat supplied to the building sufficiently to maintain a lower than normal temperature in the offices. This is a method which the average person thinks of first and is the one recommended by the government, taking 65 F as the reduced temperature. This method results in continuous discomfort to tenants throughout the entire day, and if effectively carried out would save 10 to 15 per cent in the consumption of fuel. It also presents some practical difficulties. In buildings where the radiators are controlled by thermostats, it would be necessary to reset all the thermostats and to work out some method whereby the tenants could not reset them. In buildings where the radiators are controlled by hand valves, the building is forced to depend largely upon the cooperation of the tenants to achieve the desired result. Also, unless the heating system is very well balanced so that the circulation through it is rapid, it will result in uneven heating throughout the building. In order to keep the temperature of offices at the ends of the lines from being lower than 65 F, it will be necessary to maintain a higher temperature in offices near the beginning of the supply lines.

The second method of reducing the amount of heat supplied to the building is by a reduction in the hours of daily heating. If the hours of heating are shortened an average of 1 hr per day, a saving of about 10 per cent in fuel consumption will result. This method of reduction has several definite advantages. In the first place, instead of being cold all day long, offices will be cool only in the morning and the late afternoon or evening, with normal temperatures for most of the day. In the second place, there will be no reduction in normal heating during the extremely cold weather, the larger part of the saving being in the milder weather, when the buildings do not cool off so rapidly and consequently when the tenants will not feel the discomfort so much.

Last winter we tried out such a reduction in the hours of heating in the Edison and Marquette buildings in Chicago. Fig. 1 shows the heating schedule for the Edison building. On the left hand side of the chart are the mean daily outside temperatures. The bottom of the chart represents the 24 hr period from midnight to midnight. The solid black line shows the standard heating schedule that was in effect prior to last winter, and the dotted black line shows the schedule which was in effect during this experiment. The area between the two lines indicates the saving in time of heating.

It will be noted that the larger part of the saving was made in the afternoon hours. Some saving was also accomplished by turning steam off for a portion of the night at lower temperatures than previously. Whereas we formerly kept steam on all night when the temperature got down to 15 F, during this schedule we allowed the temperature to get down to 7 F before keeping steam on continuously. The saving, on a basis of pounds of steam per degree day per thousand cubic feet of building volume, amounted to 18.6 per cent.

Checking the Marquette building data, it was found that practically the entire shortening of the heating schedule occurred in the afternoon hours. By making the reduction in schedule in the afternoon

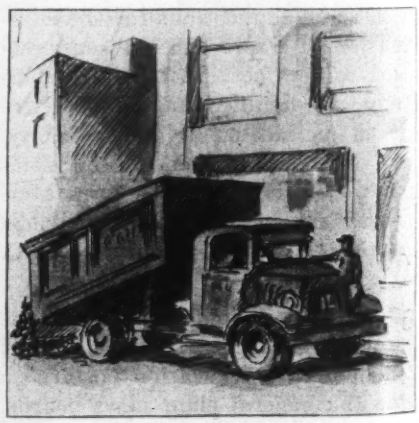
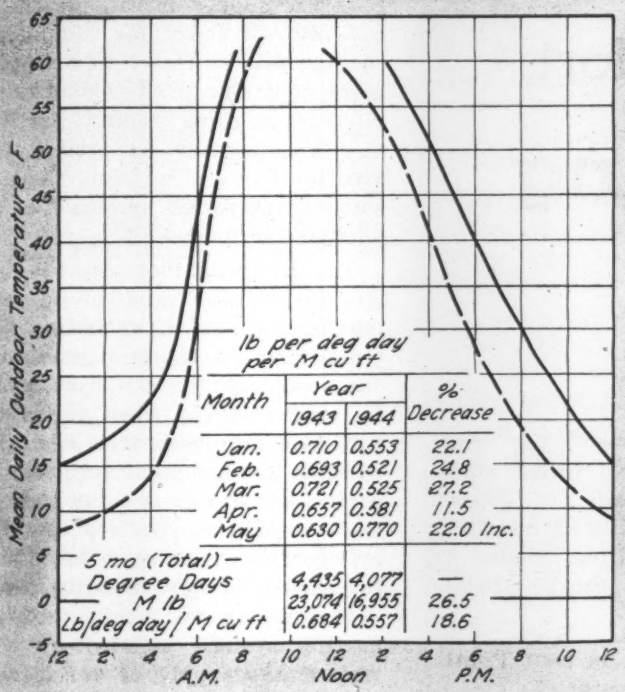


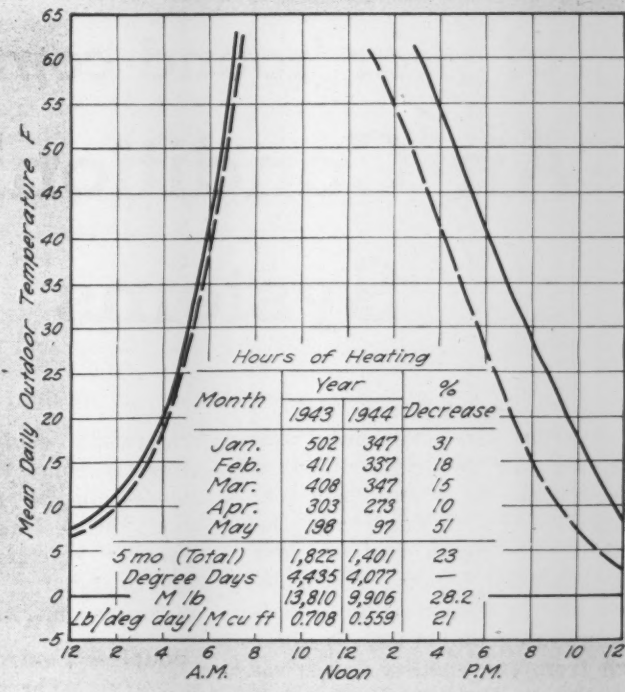
FIG. 1–EDISON BUILDING HEATING SCHEDULE



lb per deg day per M cu ft

Month	Year 1943	Year 1944	% Decrease
Jan.	0.710	0.553	22.1
Feb.	0.693	0.521	24.8
Mar.	0.721	0.525	27.2
Apr.	0.657	0.581	11.5
May	0.630	0.770	22.0 Inc.
5 mo (Total) — Degree Days	4,435	4,077	—
M lb	23,074	16,955	26.5
Lb/deg day/M cu ft	0.684	0.557	18.6

FIG. 2–MARQUETTE BUILDING HEATING SCHEDULE



Hours of Heating

Month	Year 1943	Year 1944	% Decrease
Jan.	502	347	31
Feb.	411	337	18
Mar.	408	347	15
Apr.	303	273	10
May	198	97	51
5 mo (Total)	1,822	1,401	23
Degree Days	4,435	4,077	—
M lb	13,810	9,906	28.2
Lb/deg day/M cu ft	0.708	0.559	21

instead of in the morning, the tenant finds his office comfortable when he arrives and does not notice the slight falling off in temperature that occurs after the steam is shut off in the afternoon. In the case of the Marquette building, there was a reduction of 23 per cent in the number of hours in which steam was turned on, and a reduction of 21 per cent in the amount of steam used. (Fig. 2.)

The savings in the Edison and Marquette buildings were made without much knowledge by the tenants that they were being effected. While tenants will probably not be so cooperative when the wartime fuel shortage has passed, we believe that a large part of the decrease in steam consumption can be preserved after the war.

[Editor's note: The above information is from a report presented by Mr. Shultz at a recent meeting of the National Association of Building Owners and Managers.]

RESTAURANT OPERATORS WANT AIR CONDITIONING FOR THEIR EMPLOYEES AS WELL AS THEIR PATRONS

In a "roundup" of opinion from leaders in the restaurant business to show what restaurant operators are thinking of and planning for the future, published in the October issue of American Restaurant Magazine, frequent reference is made to the need for air conditioning—not only for patron comfort, but for employee comfort, too. "Kitchen air conditioning" is mentioned several times as one of the first improvements operators plan to make. In fact, the magazine editorializes that if increased employee efficiency repays the cost of installing air conditioning, the extra patronage won by air conditioning is all profit—"and that gets to be a tremendous item!"

Here are some quotations from the restaurant operators who contributed their views to the roundup of opinion:

"Air conditioning, not only in the quarters used by the public, but by the workers, will be a matter of course."—Lucius M. Boomer, president of the Savarins, Inc., and of the Waldorf-Astoria hotel.

"Much has been accomplished in reducing the drudgery of food preparation, and if a way could be found to further control the heat and the ventilation of kitchens, it would be of considerable help in personnel problems."—Leslie C. Caldwell, president, Interstate Co.

"I'd like to see new improvements in hoods over ranges, better ventilated kitchens, and improved thermostatic controls."—Sidney Hoedemaker, president, Pig'n Whistle Corp.

"I'd like to see a great improvement in the present method of cooling and ventilating the kitchen."—Anna Maude Smith, The Anna Maude.

"Air conditioning is most important if your restaurant is to enjoy the patronage it should."—J. N. Clemons, Woodfields Inn.

"The bakery products I serve in the future must all be baked in an air conditioned, clean, cool kitchen."—Beverly Osborne, Chicken in the Rough.

Design and Control of year 'round comfort Air Conditioning Systems

In comfort air conditioning systems, air can be dehumidified at some central point and then distributed to the various zones. Dehumidification by a central plant is satisfactory because the moisture loads in a comfort air conditioning system do not usually differ much from one another in the various zones. Furthermore, as has been previously stated, in comfort work the relative humidity need not be maintained at a fixed point; it can be allowed to vary through rather wide limits as long as it does not rise above approximately 60 per cent. It is quite possible in the summertime to maintain the humidity in a number of different zones within this limit by supplying air from the central plant.

Where, however, the characteristics of the moisture load of a zone are such that it differs widely from the moisture load in other zones, separate dehumidifying apparatus and controls should be provided for such a zone. Thus, air conditioning might be installed for both an office and a manufacturing process. If the process load requires a lower relative humidity than the comfort load, and if the process humidity must be regulated closely while the comfort humidity can be allowed to vary, separate coils or washers and control systems would be essential for the two differing loads. Furthermore, if the process load requires dehumidification to a lower point than the comfort load, and if the comfort load was a large percentage of the total load, it might even be desirable to install separate refrigerating equipment for operating economy. No broad statements can be made, of course, about the desirability of installing separate refrigerating plants as each installation must be studied on its own merits.

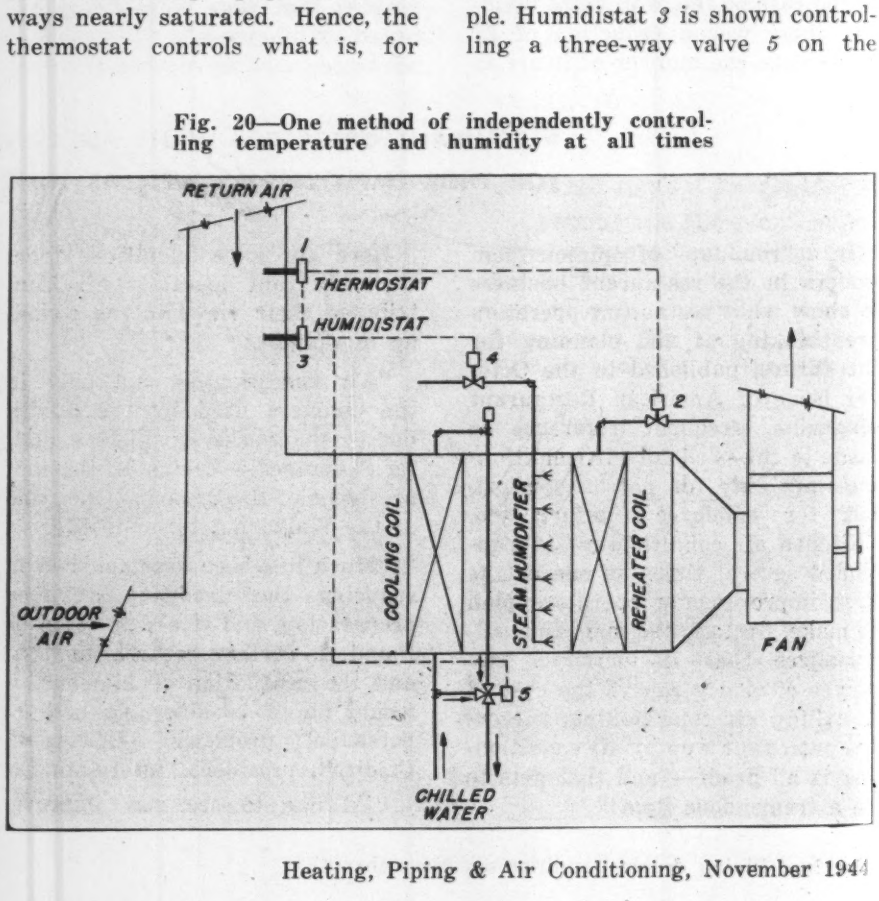
Simplest Control Is Dew Point Thermostat

The simplest type of control and one that is widely used consists of a thermostat in the stream of air leaving the cooling and dehumidifying apparatus. Such a thermostat is called a "dew point thermostat" because the air leaving the conditioning equipment is always nearly saturated. Hence, the thermostat controls what is, for all practical purposes, the dew point temperature of the air supply. The dew point thermostat controls the supply of refrigerant to the coil. Usually, for simplicity, the thermostat is set to maintain a constant dew point temperature, although in some systems, particularly the primary air system, the setting of the dew point thermostat may be varied by means of an outdoor thermostat.

The dew point thermostat is simple, inexpensive, and gives good results. However, in reheating systems it does not permit maximum operating economy to be achieved. In such systems, when the moisture load decreases, it is desirable to raise the dew point temperature of the air supply so that less reheating will be required and the refrigerating capacity reduced during periods of light moisture loads.

For economical results in a reheating system, satisfactory control of the supply of refrigerant to the cooling and dehumidifying coil can be obtained by installing a humidistat in the return air. The return air, of course, must be a representative sample of the air in the various zones. The humidistat should control the refrigerant supply to the dehumidifying apparatus as illustrated in Fig. 20, for example. Humidistat *3* is shown controlling a three-way valve *5* on the

Fig. 20—One method of independently controlling temperature and humidity at all times



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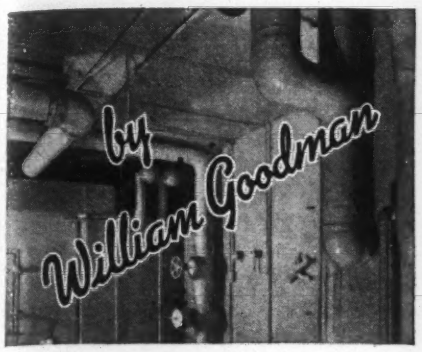


cooling coil. Consequently, the temperature of the air leaving the cooling coil is raised or lowered in accordance with the humidity requirements in the conditioned space. Such control provides for economy inasmuch as the refrigerating load is varied in accordance with the relative humidity. This type of control is especially desirable in straight reheating systems, providing a sensitive and accurate humidistat device is used.

In a central plant the dry bulb temperature can be regulated by a thermostat controlling the reheating coil. In zone systems, of course, the thermostat in the return air from each zone or in the zone itself will control the reheat coil. In the control system illustrated in Fig. 20, thermostat *1* controls valve *2* on the reheating coil. The thermostat controls the reheating coil so that only enough heat is added to the air supply to maintain the desired dry bulb temperature.

A crossover connection between the thermostat and humidistat should be provided so that in the event of light moisture load and heavy sensible load the dry bulb thermostat could control the chilled air through the coil. As an extreme illustration, in the event of zero moisture load, the humidistat would maintain the temperature of the air supply at the room dew point temperature. If the sensible load should increase, the thermostat would first close down the reheating coil completely. After reheat is shut off, a supplementary contact on reheat steam valve *2* would, on a further slight rise in temperature, place the three-way valve *5* under control of thermostat *1*. Thermostat *1* would then increase the supply of refrigerant enough to lower the temperature of the supply air sufficiently to take care of the sensible load. The humidity under this condition would, of course, be lowered, but no harm would be done on a comfort job. On a process job where exact humidities must be maintained, this can be accomplished by means that will be discussed later in this article.

The crossover connection between the humidistat and thermostat is also desirable in systems which operate only during the day and are shut down over night. When starting up, even though the dry bulb temperature is high, the relative humidity might be low enough to prevent the humidistat from opening up the supply of refrigerant to the cooling coil. Without a crossover connection, a manual switch would be needed to maintain the supply of refrigerant until normal operating conditions were obtained.

Control of a Zone System

In a zone system, all of the zone thermostats could be provided with crossover connections to a single humidistat. In this case, after the thermostat in any one zone is completely cut off, a further rise in temperature would place the central dehumidifying plant under control of the thermostat in the zone with the heavy sensible load. The thermostats in the other zones would, of course, maintain the proper dry bulb temperatures by opening up the reheat coils wider. Admittedly, for a zone system, lowering the humidity in a number of spaces just to satisfy the heat load in one zone is uneconomical. However, the cost would be unimportant here because such an occurrence on the average air conditioning installation is likely to be rare; it is more in the nature of an emergency control than of an operating control. However, when the humidity characteristics of a certain space vary widely from the rest of the spaces, then for economical results a separate dehumidifying apparatus should be provided. This, however, is usually not necessary in air conditioning for comfort only.

A crossover connection is fairly simple and inexpensive to install in a zone system having a limited number of zones. However, in a system in which there are a large number of dry bulb thermostats in a large number of different zones, the crossover connection from each thermostat to the main humidistat may unduly complicate the control system. In this case, it may be best to omit the crossover connection and provide a manual switch to permit refrigerant to be supplied regardless of the humidity. Such a manual switch is particularly necessary, as was mentioned, for morning start up of systems which have been shut down the previous night.

Control of Direct Expansion Coils

When direct expansion coils are used for cooling and dehumidifying the air, the temperature of the supply air leaving the dehumidifying coil can be controlled satisfactorily. In this case, instead of using the three-way valve *5* as illustrated in Fig. 20, a modulating throttling valve can be installed in the suction line between the direct expansion coil and the suction of the compressor as shown in Fig. 21. The operation of the throttling valve *3* is controlled by means of the humidistat 2. If the humidity of the return air rises, the humidistat *2* opens the throttling valve wider, thus lowering the temperature of the boiling refrigerant inside the evaporator. As the humidity falls, the humidistat will move the throttling valve to a more nearly closed position, thus raising the temperature of the boiling refrigerant inside the evaporator. In this manner the dew point temperature of the air supply is raised and lowered in accordance with the humidity requirements. The dry bulb temperature is, of course, controlled by the reheating coil.

SUMMER CONTROL OF HUMIDITY

The basic principles that govern the design and control of year 'round comfort air conditioning systems are organized and discussed in the series of articles of which this is the ninth, and which is devoted to methods of controlling humidity in summer operation. The author, a consultant, has been named research professor of refrigeration and air conditioning at Illinois Institute of Technology.

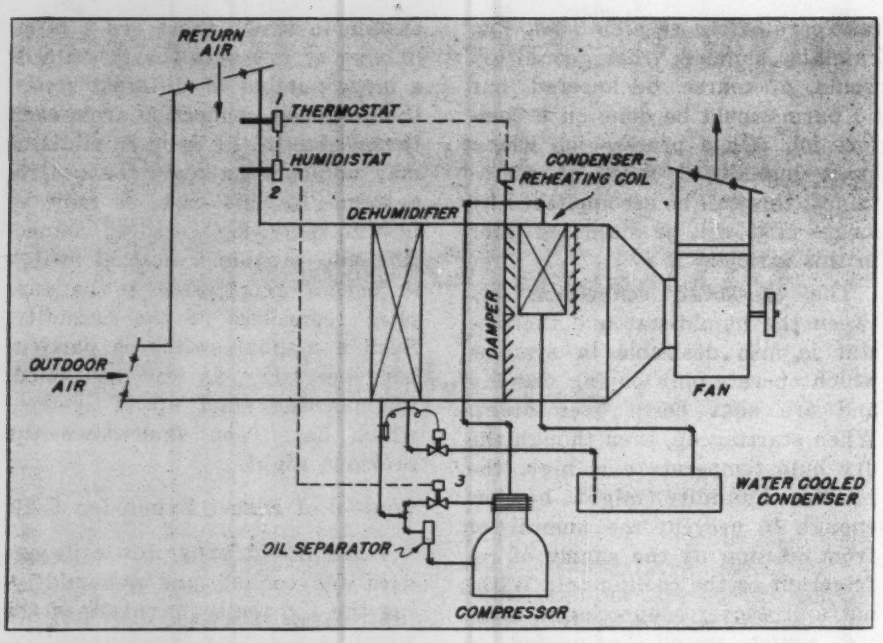


Fig. 21—Reheating air by means of hot condenser gas and control of humidity by means of modulating valve in suction line to compressor

The type of control shown in Fig. 21 is flexible. If desired, a step controller can be used to synchronize the operation of the throttling valve *3* with capacity control of the compressors. For example, using several compressors, at several separate positions of the step controller, a compressor is either started or stopped. In between the start-and-stop positions of the step controller, the operation of the throttling valve can be controlled by the modulating action of the step controller. Thus, only as many compressors as are needed would be running and an exact balance point with the required refrigerating capacity would be obtained by means of the throttling valve in the suction line. In this manner, cycling of compressors or of any step of capacity control can be avoided.

To illustrate the action of the step controllers without a throttling suction valve, assume that in a given installation three compressors are installed and that the load is too large for two compressors and too small for three. In this event the third compressor will start and stop frequently. With a throttling valve installed in the suction line, the third compressor will run as long as the load is greater than can be handled by two compressors.

Whenever a throttling valve is used in the suction line, an oil trap should be installed ahead of the throttling valve with a small oil return line from the oil trap directly back to the crankcase of the compressor, as shown in Fig. 21. In this manner, positive return of oil is assured in spite of the damming effect of the throttling valve in the suction line.

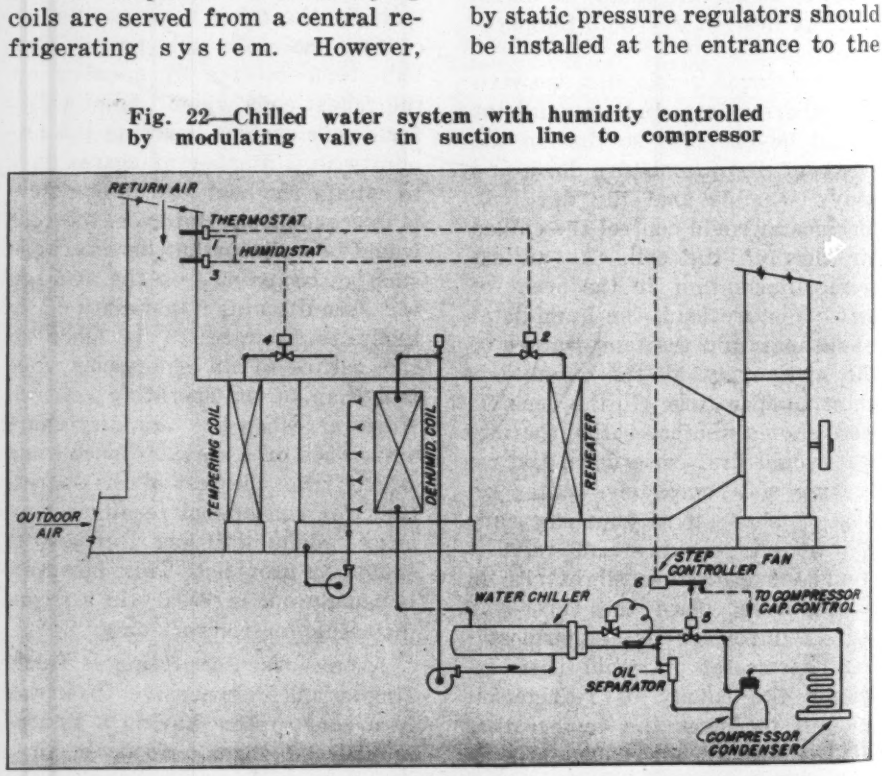
In Fig. 20 the humidistat is shown controlling a three-way valve in the chilled water line. This method is a satisfactory one when several separate dehumidifying coils are served from a central refrigerating system. However, where dehumidified air is supplied from a single central plant and the air is to be dehumidified by means of chilled water, a throttling valve in the suction line can be controlled directly from the humidistat as shown in Fig. 22. The only difference between the systems shown in Figs. 20 and 22 is that the three-way valve *5* of Fig. 20 is omitted. Instead, in Fig. 22 the humidistat *3* controls a throttling valve *5* in the suction line between the water chiller and the compressor. In this manner the temperature of the water is raised and lowered in response to the humidistat. Operation is exactly the same as previously described for a direct expansion coil.

For the system shown in Fig. 22, no control of water temperature is provided nor is any needed. The layout of Fig. 22 is more economical without control of water temperature. During periods of light moisture load, the water temperature rises and the humidistat keeps only as many compressors in operation as are required by the load if a step controller is used.

Double Duct System

For control of dry bulb temperature in a number of individual zones, a double duct system of the type illustrated in Fig. 23 can be used. In this case, damper control by static pressure regulators should be installed at the entrance to the

Fig. 22—Chilled water system with humidity controlled by modulating valve in suction line to compressor



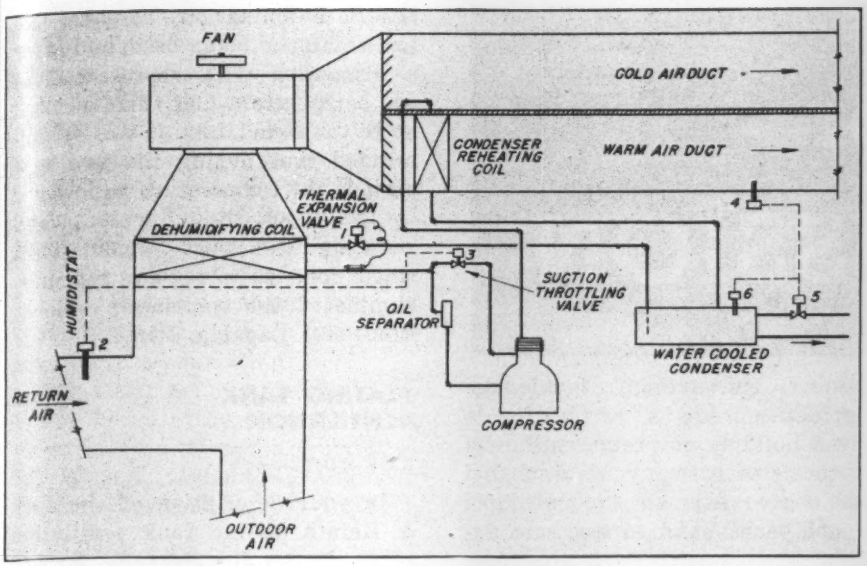


Fig. 23—Two duct system with air reheated by hot condenser gas and control of humidity by means of throttling valve in suction line to compressor

hot and cold air ducts to maintain constant static pressure in these duct systems and to shift the air automatically from one duct to the other as the various zone dampers open and close. Control of the temperature of the warm air is desirable so that as stable conditions as possible can be maintained. Most of the variation in temperature can be avoided, as shown in Fig. 23, by means of dry bulb thermostat *4* in the warm air duct after the reheating coil. This thermostat can actuate valve *5* controlling the supply of water to the condenser. As the temperature of the supply air rises, more water will be supplied to the condenser and thus the condensing temperature on the high side is lowered. On falling temperature, the water supply would be decreased slightly to raise the condensing temperature. Variations in condensing pressure would not be great. The controls could be connected so that after the condensing pressure rose to a certain maximum limiting point, it would automatically be maintained at this point by pressure regulator *6* controlling water valve *5*. Operation at the maximum pressure could occur only when the dew point temperature of the supply air rose to a high point due to the moisture load being light, and would probably be a rare occurrence.

Pressure regulator *6* would also have to operate to prevent the pressure in the condenser from falling too low to prevent difficulties with the operation of the expansion valves. With the automatic water valve on the condenser controlled from the temperature of the warm air, and a pressure regulator on the condenser acting only to prevent extremes of pressure—high or low—,control by the dry bulb thermostat would be limited; but within its limitations, it would help to avoid most of the variations in dry bulb temperature. Furthermore, operation at the limiting positions would be rare and would usually not be serious.

Use of a Differential Thermostat

In the methods outlined in this section for summer control, the heart of the control is, of course, the humidistat. Upon its functioning largely depend both the proper operation of the control system as a whole and the operating economy of the installation. If the humidistat is inaccurate or tends to run the compressor for unnecessarily long periods, the humidity will be pulled down to too low a point, thus increasing the operating expense. On the other hand, if the humidistat is slow to respond, the humidity may rise to uncomfortable heights before the compressor starts to run.

One type of good humidity control is a differential thermostat. Such a thermostat uses two bulbs, one of which can be used as a dry bulb and the other as a wet bulb. However, the wet bulb should not be covered with a wick. It has been the writer's experience that such wicks need too frequent changing. Even when they are clean, they may not be altogether satisfactory because of the precipitate left by the evaporating water. A better plan is to immerse the wet bulb in a small and shallow insulated tray of water. The depth of the tray should be about equal to the diameter of the bulb. Distilled water is desirable for make-up but not strictly necessary. The tray itself should be exposed to the return air. In this way the water will always be very nearly at the wet bulb temperature. The tray and wet bulb will, of course, need cleaning, but once cleaned, they will be accurate for a much longer period than if a wet wick or porous tube is used. The advantage of a differential thermostat lies in the fact that it responds much more quickly and rapidly to changes in humidity than a humidistat using organic materials. Such a differential thermostat can be depended upon to provide good control and good operating economy.

Of course, the differential thermostat does not provide exact control of humidity under widely varying dry bulb temperatures. Thus suppose that the device is set to maintain a difference of 13 deg. With an 80 F dry bulb, a 13 deg difference would mean that the conditioned space was being maintained at a relative humidity of 50 per cent. However, at 72 F the relative humidity being maintained with a 13 deg difference between dry bulb and wet bulb temperature would be about 45 per cent. In comfort cooling, this variation would not be important.

BUY AND HOLD WAR BONDS!

"OPEN for DISCUSSION"

WARTIME FUEL EFFICIENCY

THE EDITOR—

I wish to commend you on the effective cooperation which your journal is giving to the national fuel efficiency program sponsored by the Bureau of Mines.

The group of articles by Kalman Steiner on Wartime Fuel Efficiency, in June, August, and September, have been interesting and to the point in giving people a better understanding of the fundamentals of combustion efficiency. The other articles, which you have published from time to time in your magazine, must be very useful to spread needed information on fuel saving. —A. C. FIELDNER, Chief, Fuels and Explosives Branch, Bureau of Mines, U. S. Department of the Interior.

ESTIMATING AND CONTROLLING HEATING FUEL REQUIREMENTS

THE EDITOR—

It seems to the writer that R. A. Small has injected two quantities in his proposed method of estimating fuel requirements (published in the October HPAC) that are subject to individual interpretation between heating engineers, namely, (1) the calculated heat loss of the structure, and (2) the design temperature of the locality.

It appears that estimates of future requirements based on past fuel consumption records correlated with degree days would provide a better basis for an estimate of future requirements for a given period.

Irrespective of calculated heat losses, of the design temperature, or of the type or types of heating equipment installed, a single building or group of buildings in a given locality will require heat in proportion—roughly, at least—to the number of degree days that occur. By determining a factor for a given building or group, expressed in terms of so many units of fuel per degree day, an adequate tool would be at hand to estimate future requirements. Such procedure would appear to be more reliable because of the actual operating experience involved. Appreciable variations in combustion efficiency of a given heating plant or group of plants, however considered, would be reflected in variations of the factor.

Unless construction at the various control centers is somewhat uniform, a comparison of combustion efficiency between units may not be feasible. However, the above should prove helpful in estimating requirements.

The Army has made a rather extensive study of the fuel requirements of various types of buildings most common at posts, camps, and stations and has evaluated factors for each, expressed in terms of pounds of standard fuel (12,500 Btu = 1 lb) per 1000 sq ft of floor area per degree day. This has proved to be wholly satisfactory and a fairly accurate method of determining fuel requirements.—RICHARD E. BILLER, Mechanical Engineer, Fuel & Heating Unit, Repairs & Utilities Branch, Office, Chief of Engineers, War Department.

CHANGING VERSUS CONSTANT TEMPERATURE

THE EDITOR—

Regarding the question of changing temperature versus a constant one, as discussed on pages 568 and 569 of the October HPAC, I wish to add to the comments a case I was called in on.

The employees complained of feeling stuffy and uncomfortable after the shift had worked for some time. Examination revealed no toxic material being used, and after a discussion with representatives of both labor and management as to the complaints, it was recommended that during the two rest periods the temperature be lowered by increasing the outdoor air and reducing the heat input. This, when done on a regular schedule, eliminated the complaints.—K. E. ROBINSON, Lansing, Mich.

PLATING TANK VENTILATION

THE EDITOR—

In your description of the Jack & Heintz plating tank ventilation plant, in the July issue of HPAC, you mention the problem caused by the large quantities of air required to make up the extracted air. It may interest your readers what measures have been suggested elsewhere to overcome this trouble.

1) For economical reasons it is impracticable to heat a quantity of outside air similar to the extracted quantity in winter. Such quantity would be required to balance the pressure and to prevent draft, and heating would be needed to obtain comfortable conditions in the room through which the air flows.

With the arrangement shown in the accompanying Fig. 1, an auxiliary system supplies the surplus of air which is not required for proper ventilation of the room. This additional air is distributed over the center of the tank and flows down into the extraction slots. As the path of flow is beyond the working space (except for the operator's arms, which can be protected if need be), this air need not be heated.

Sometimes it may suffice to connect the distributions with the outside through the roof whereby a slight vacuum still exists in the room. A better solution is to have a fan delivering the surplus air. In this case the air may be filtered and chromium be recovered from the extract system clean and fit for re-use.

2) The extraction system handles large quantities of air in order to obtain sufficient speed over the tank and to seal it against the surrounding.

A more efficient air blanket can

be accomplished by distributing small quantities of compressed air through narrow slots, as shown in Fig. 2. With this arrangement the quantity of extracted air can be reduced considerably to only that much that is supplied by the jet system and in addition what quantity is entrained by the high speed air. The reduced quantity of air means higher concentration of chromium which thus can be recovered more economically.

The latter solution is also preferable because the overhead space remains free from obstruction.—M. HIRSCH, Consulting Engineer, London, England.

BURNING OIL IN WARTIME

THE EDITOR—

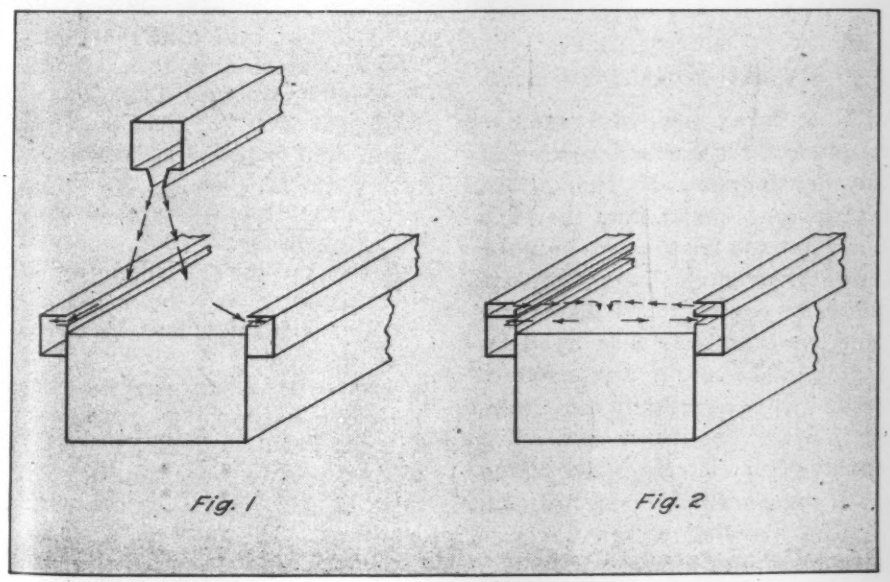
I believe Mr. Meyer's article, Burning Oil in Wartime, published in the October HPAC, is excellent. His description of the market conditions over the past few years is especially interesting. Particularly trenchant is his observation that under the conditions imposed by present-day equipment and fuels, the oil burning system must be designed as a unit.

I assume that the diagonal lines of the viscosity chart with his article represent the temperature-viscosity curves for seven typical fuel oils. My experience is that each fuel oil curve has a slope peculiar to itself and that the curves for a group of individual oils will not be parallel, but will tend to converge or even to cross. No doubt the chart is an adaptation of typical experimental data, arranged to permit rapid estimation of viscosity variation with temperature.

The concept of pumpability is naturally a relative one. There are many factors entering into fluid flow, particularly the Reynolds number. I think it rather a broad generalization to predicate pumpability upon viscosity alone. The other elements of a piping system cannot be ignored: pipe diameter and length, permissible pressure drop, velocity of flow, etc. Since Mr. Meyer makes special reference to required temperature on the suction side of the pump, and since temperature is only a reflection of viscosity, I believe the point should be amplified that since suction can exist only while the pressure drop is less than atmospheric, the limit of pumpability is that value of the Reynolds number which gives a pressure drop that can be overcome by atmospheric pressure. This means, of course, that the size of pipe and rate of flow and length of pipe must be considered, as well as temperature and viscosity, in establishing pumpability.

As to flow on the pressure side of the pump, the total pressure drop is perhaps less important than on the suction side, providing power consumption is not a consideration. In other words, if it can be assumed that the pump is driven by a source of unlimited power, and the expenditure of power is not of importance, then the limit of pumpability can be expressed in terms of viscosity. But in every day practical operation, the limits of pumpability are the power that drives the pump and the pressure limits under which the system is designed to operate. If one were seeking a universal determinant of the fuel system as a unit, one has to revert to the Reynolds number. —KALMAN STEINER, Member of HPAC's Board of Consulting and Contributing Editors.

Plating tank ventilation



When engineers gather to hear a paper or talk, there comes a time when the meeting is thrown "open for discussion." Some of the audience may offer comment amplifying the speaker's remarks, others will disagree with points the speaker may have made, and some will want to ask questions for the speaker to answer . . . We follow this custom in these columns, which provide an opportunity for readers to comment and discuss articles published in HPAC and other topics of interest to heating, piping, and air conditioning engineers and contractors.

URGES COMPLETION OF PUBLIC WORKS PLANS

Plans for postwar public works projects by state and local governments need to be expedited if they are to have any particular effect on employment and business conditions in the period of transition from war to peace-time, H. E. Foreman, managing director of the Associated General Contractors of America, national trade association of leading construction firms, declared last month.

Results of the survey made by the Federal Works Agency for the House committee on postwar economic policy and planning, Mr. Foreman pointed out, show that the plans of state and local governments in the completed stage total $969,858,000 as compared to a total of $1,749,242,000 in the design stage, $3,701,884,000 in the preliminary stage, and $6,297,387,000 in the idea stage.

"More of these plans need to be brought to the completed stage," he said, "because it usually takes longer to bring such projects to the start-work stage than it does to build them."

A HISTORY OF PIPING

The Role of Steam in Piping Development

UNTIL THE TIME when men began to use steam for power and heat there was very little need for piping. The small amounts of piping used were for water and drainage. Few cities had waterworks, and these were thoroughly inadequate; none had complete sewer systems as we know them today. Certainly the requirements of steam engines, boilers, and building heating systems can be called man's third great need for piping. Steam for power, because it constantly called for better piping and connections, did more to develop present-day piping than any other application.

The Steam Engine

No machine was more talked about before it was invented than was the steam engine. By 1700 scientists had proved its practicability and many were trying to invent it. Water power was not available everywhere and people could see where steam power was needed to operate the pumps of waterworks and mines. As a result, each of the early inventors of the steam engine attached his contraption to a pump and endeavored to demonstrate how much water could be pumped to a given elevation in a given time.

The earliest mention of piping in connection with steam engines tells how a German inventor, after finally getting the much-desired audience of his landgrave, failed to get the demonstration under way because his piping leaked so badly. The landgrave walked away in disgust, leaving the distraught inventor with his leaking pipes and sputtering engine.

The first successful steam engine was Thomas Newcomen's atmospheric steam engine, developed in cooperation with aging Thomas Savery and patented in 1711. Many Newcomen engines were built and installed during the following 70 years. In this engine the steam forced the air out of the cylinder, then condensed (with the aid of a spray of cold water), leaving a vacuum. The atmospheric pressure of the air, "abhorring a vacuum," as the school books say, forced the piston back and with this backstroke pumped the water. A very limited amount of steam conducting pipe was used on these engines, just enough to incorporate a valve, as the cylinder rested on top of the boiler. This valve, and the one that let the condensate out of the cylinder, were the simplest kind of cocks and at first were operated by a "valve boy." One such boy, Humphrey Potter, in 1713, tied strings from the piston to the valves, made their operation automatic. In 1718 Henry Beighton patented a device incorporating Potter's idea. Water lines to Newcomen engines, like almost all of the engine itself, were mostly of wood, a few were metal.

In 1769, after repairing one of Newcomen's engines, handyman James Watt patented a separate condenser which enabled keeping the cylinder hot (heated with a steam jacket) and making better use of the steam. In 1775, then a partner of Boelton & Watt, steam engine manufacturers, Watt developed the double acting steam engine in which steam forced the piston both out and back with powerful and fast strokes. Watt began manufacturing this engine immediately though the patent was not granted until 1782. In the meantime, Jonathan Hornblower, apparently because he had less trouble with patent procedure, patented the compound steam engine for which Watt had also applied. Soon after that, Prichard patented the application of a steam engine to crankshaft and flywheel. Watt added other improvements, including the centrifugal acting governor.

Competition between steam engine manufacturers was intense all during the 1800's, with each manufacturer's improvement demanding improvements in competitors' engines and all efforts tending toward better engines at lower prices. Simpson Compound, Holly-Gaskill, and Corliss were some of these famous engines. The superachievement of them all was the great Corliss engine at the Philadelphia Centennial in 1876. It was 39 ft high, weighed 1,792,000 lb, developed 1500 to 2500 hp, and drove eight miles of shafting.

In 1884 Sir Charles Parsons developed the first successful turbine. The improvements that followed and the turbine's adaptability to electric power and the more efficient centrifugal pumps foreshadowed the end of the great age of cylinder-type steam engines. By 1901, 400 kw turbines were operating at 3600 rpm; by 1905, 5500 kw turbines were operating at 750 rpm. Today 65,000 kw turbines operate at 3600 rpm and 75,000 kw turbines at 1800 rpm, with the

By M. A. Hasselmann

of Tube Turns, Inc., who resumes this month his interesting story of the development of piping and piping connections from the very early days to the present. Until the time when men began to use steam for power and for heat, there was comparatively little need for piping (although it was used of course for water supply and drainage). Steam for power, because it constantly called for better piping and connections, perhaps did more to develop present-day piping than any other application

trend to still larger capacities running at the higher speeds.

Steam Piping

As the steam engine developed it required more and more piping, especially after the engine became separate from the boiler and eventually was housed in a separate room or building. Until well into the 1800's, all steam pressure lines were of cast iron and some cast iron steam lines were used until well into the 1900's. As machine made wrought iron pipe became available, and in larger and larger sizes, it became preferred to cast iron. Lap welded wrought iron steam pipe predominated during the latter part of the 1800's until, late in the 1890's, lap welded steel pipe began to be preferred. One also saw considerable riveted spiral seam steam piping. By the 1920's seamless steel steam lines were seen here and there, and since 1930 seamless low carbon or alloy steel piping has been standard construction wherever the higher pressures have been involved.

The first insulation for steam lines was wood boards, fitted carefully and secured with strapping; there are steam lines still in service with such insulation. Asbestos and magnesia insulations appeared in the last part of the 1800's and were in loose form with a wrapping. Today such insulation comes molded to fit the piping, as do other types.

Connections and Fittings

Connections were always a problem for pipes carrying steam. Flanged-at-both-ends piping with a thick lead gasket was used in the earliest steam lines. Machining the faces of the flanges came during the 1830's and helped contain the increasing pressures. No doubt present serrated and phonograph finishes of flange faces can trace their ancestry to the faulty machining of that day. Some packed bell and spigot connections were used on steam lines during the 1800's, as were some threaded and gasketed bell and spigot connections, which are occasionally seen today.

By the 1890's connections for steam piping had become quite a problem due to the prevailing higher steam pressures, and the appearance of the Van Stone joint, 1897, saved the day.

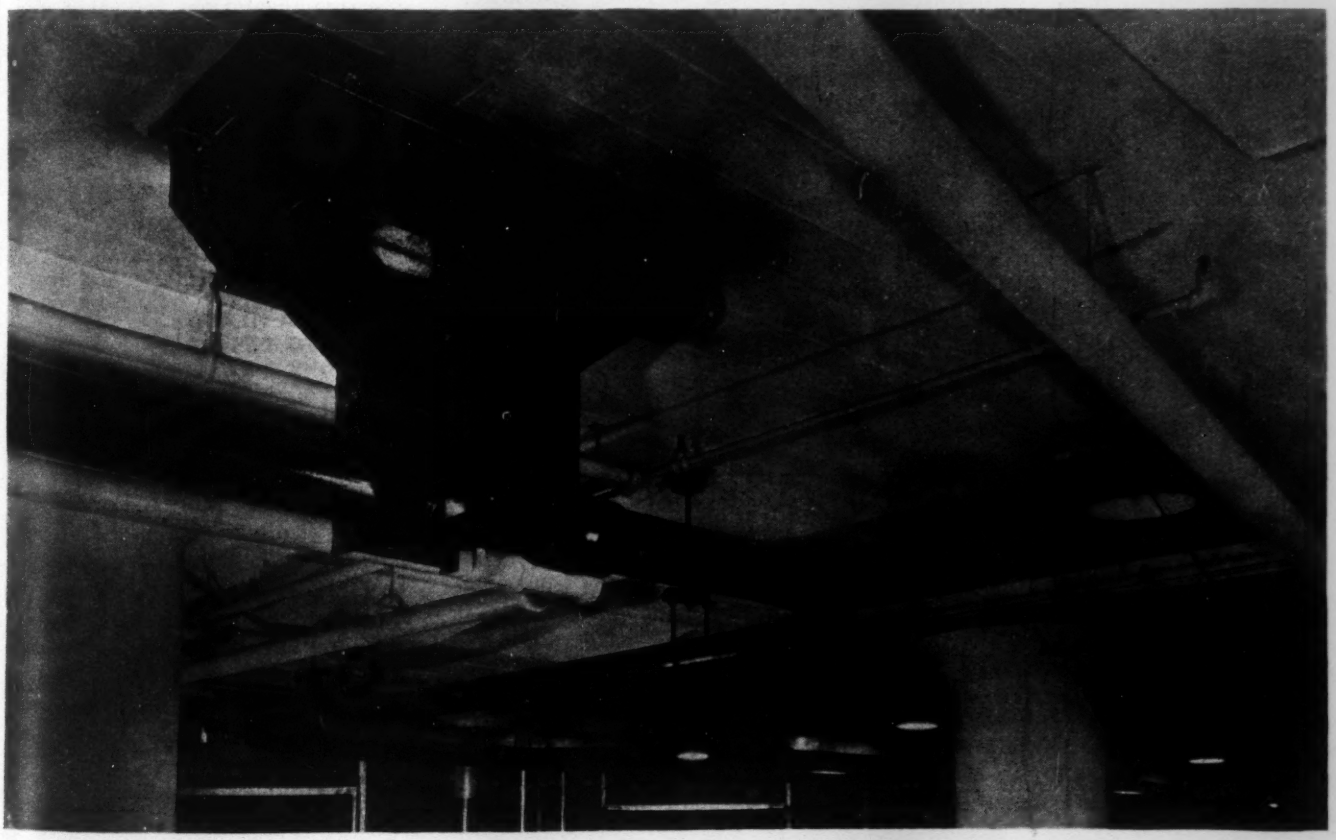
Welded construction is accepted and standard for steam lines today and, in the high pressure lines, it is used even for the connections to valves, pumps, etc. For pressures that are not extreme the use of flanged connections, over welding butts, is accepted construction.

During the latter part of the 1800's, as live steam was often being conducted for considerable distances and was being used at higher and higher temperatures, pipe expansion became a problem. Many expansion type couplings were developed, on the principle of one pipe sliding within another. Many of these expansion joints are used today on steam lines and lines other than steam, as they are adequate for all but the extreme pressures now dealt with in steam generating plants and oil refineries. For the latter applications the various types of pipe bends are the answer, utilizing the flexibility of the pipe and requiring no severance of the pipe.

Steam and Hot Water Heating

Sir Hugh Plat seems to have been the first to use steam heating. In 1653 he installed steam heating in his greenhouse, "thus maintaining a constant temperature." Knowing

A 6 in. arc welded steam main



how crude and unreliable Sir Hugh's boiler and piping had to be, we must question the reference to the constant temperature, for extended periods, at least. While the ancient Romans had brass heating coils to warm the water in their public baths, there is no evidence that they ever conducted steam or hot water to radiators in rooms.

We next hear of steam heating in 1784, when James Watt installed a home-made steam radiator in the office of his steam engine factory. This radiator's dimensions were 3½ ft by 2½ ft by 1 in., and it was made of sheet copper. It had an air cock and condensate return and was connected to the boiler supplying the plant's steam engine. The pipes were probably copper. Before he died, Watt suggested the first use of engine exhaust steam to heat buildings. The suggestion was made to a textile mill that had just installed one of his engines. The use of exhaust steam for heating factories developed steadily after that, being given considerable impetus when vacuum heating systems were introduced in the late 1800's.

Soon after the turn of the last century members of a family named Perkins were installing steam heating systems in wealthy British homes. There must have been at least one such heating system in New York City before 1841 that must have been seen by the brothers-in-law, J. J. Walworth and James Nason, and which influenced their going into the steam heating business. They bought out a small New York pipe jobber and the following year moved to Boston, which they considered a better market for heating equipment. There they manufactured and installed steam and hot water heating systems for hotels, stores, institutions, factories and large homes, and before the middle of that century had installations as far away as the state of Mississippi.

The first large steam heating installation seems to have been in Boston's Eastern Hotel, 1844. Steam pipe coils were placed "anywhere that drafts came in." Whether the steam heating made much noise or dissipated too much heat is not reported, but it is reported that when the steam was turned on (at regular intervals during the day) the occupants left their rooms. Steam heating for passenger ships became the natural and accepted thing before the end of the 1840's, a number of installations having been made during that decade.

Steam heating, with hot water heating trailing far behind, was confined for the most part to the larger structures until the turn of this century, when there was a definite trend to installations in the better residences. Up to that time fireplaces, supported by small room stoves, were the preferred heating for the home or office. Even in the large buildings, especially where no exhaust steam or district steam was available, the use of steam heating developed slowly—as late as 1895 it is understood that Chicago's reputable Palmer House had pot-bellied heating stoves in each of its 700 rooms. With the construction of large stores and office buildings, begun in the 1890's and reaching a peak in the 1920's, the use of steam heating proceeded by leaps and bounds. It also extended down into the smaller residences. The development of better steam piping, at lower and lower costs and at the rate of millions of feet per year, was one important reason for this impressive growth.

The earliest heating systems used cast iron or copper piping, but the early American heating contractors used wrought iron piping almost exclusively. As with gas piping, butt welded wrought iron pipe with threaded connections was thoroughly practical for the low pressure lines. Some lap welded pipe was used, especially for the larger steam lines. The cast iron pipe that was installed usually had packed bell and spigot connections and you could get into an argument over the comparative merits of packed or screwed connections as late as 1870. During the 1890's the heating industry began to use steel pipe, as other industries were doing. Not much copper or brass was used for steam heating lines until well into this century. Air conditioning has prompted the use of considerable brass and copper tubing.

District Steam Heating

Centralized or district steam heating, by which many business buildings, residences, and factories of the central areas of many large cities are supplied with steam for heating and power, seems to have originated in 1876 at Lockport, N. Y.—the invention of Birdsill Holly, whose original installation serviced a number of homes and stores in the vicinity of his residence and called for 490 ft (and return) of insulated ½ in. pipe. Holly incorporated soon after this and had 2350 ft (and return) of 1 in. and ¾ in. steam mains. He even planned to pipe steam to every street corner where it could be used by fire engines for pumping the water from the hydrants adjoining the steam outlets!

The central heating systems of university campuses, institutions, camps, etc., were prompted by the success and efficiency of the early district steam heating companies.

Much of the development of the present-day science of conveying steam long distances is due to the efforts of companies promoting district heating. Large operating savings resulted from each development of more efficient and dependable piping and connections, more effective insulation, improved tunnel construction. Some of the district steam lines installed 50 years ago, enclosed in wood casing as a conduit and insulation, are still in use.

[Photo courtesy of Lincoln Electric Co.]

VERMILYA HEADS HOUSING RESEARCH

The appointment of Howard P. Vermilya as director of housing research was announced last month by J. F. O'Brien, general manager of the John B. Pierce Foundation. Mr. Vermilya, member of the American Institute of Architects, has for the past 10 years been connected with the Federal Housing Administration as technical director.

The Pierce Foundation is stressing the development and adaptation of raw materials, equipment, and techniques to housing production.

SAM LEWIS' PAGE

In this regular feature, informal comment on heating, piping, and air conditioning problems and their solutions is given—at the request of the editors—by Samuel R. Lewis, consulting engineer, and a member of HPAC's board of consulting and contributing editors

To Exhaust Air, You Must Supply Air

SEVERAL RECENT experiences of my office have concerned "putting in something to take out." One of them involved a large forge shop housing many oil heated refractory-lined reverberatory furnaces into which cold steel billets are delivered by power operated tongs. The products of combustion from the furnaces escape into the interior of the shedlike building, no chimney being allowed since visual observation of the escaping gases to assure proper temperature is said to be necessary.

The billets of white hot metal, when withdrawn from the furnaces, are transferred quickly to enormous vertical steam hammers and presses to be forced into dies that give them the finished complex shapes. During the forging process, the scale is blown off with powerful jets of water and compressed air.

The interior of the building, therefore, is an inferno of smoke, gas, steam, noise, and vibration. An attempt to alleviate these conditions was made by installing axial flow overhead exhaust fans discharging horizontally through former windows in the sides of the monitor that extends the full length of the forge shop. These fans succeeded in producing reasonable comfort and visibility for a few feet inward from the open sides of the 80 ft wide shop, but the entering air tended to rise quickly as it became warm and accomplished little good for the central spaces. The fans, delivering air outward through both sides of the central monitor, were handicapped if a strong wind exerted pressure against them. An addition eventually was built paralleling one side of the long shop and this blanked off one-half of the former entrances near the floor for outside air. Following this, more and more exhaust fans were installed, without appreciable alleviation of the trouble.

There were many portable and powerful man cooling, pedestal mounted, recirculating fans that could be moved to direct blasts of air toward the workmen, but they handled the mixed gases and if near a truck load of hot forgings, delivered what air they did deliver at a high temperature.

The shop became hotter and more obscured as the output increased. Adding more exhaust fans did not improve the situation. Then high-up windows between the fans were opened and great volumes of outside air entered, passed to the fans, and departed without ever getting down to the hot zones where most of the men toiled. This entering short-circuit air did, however, make life endurable for the few maintenance men who worked on lofty catwalks servicing the steam cylinders of the forges.

It was clear that the answer to this case must be found by introducing air from outdoors through ducts from fans that could deliver and distribute it near the floor in the populated zones. When steam is present in cold weather particularly, the air supply must be heated or visibility will be greatly impaired by the fog.

The delivery into the shop, at strategic locations, of outside air through adjustable high velocity nozzles at a level 10 ft or less from the floor, in combination with vertically discharging, high-up exhaust fans corrected the trouble. Constant control of opened, high-up windows to prevent short circuiting of the air from the outside to the exhaust fans was necessary, such short circuits being permitted only to a limited extent for protection of the maintenance men.

A peculiarity in heavy duty forge shops like this is that the enormous foundations of the hammers, as deep in the ground as they are high in the air, preclude use of underfloor air supply ducts. It was observed, however, in another portion of the plant where heat treating was carried on, and where underfloor air admission ducts were practicable, that these, delivering air upward through heavy gratings, accomplished satisfactory scavenging of the gas laden air.

"Put and Take"

The process of ventilation means that we must put *in* if we would take *out*. In a highly specialized chemical manufacturing plant, expanded rapidly for war production, exceedingly odorous and often dangerous gases were generated. The roof was pierced by many wood chimneys designed in the hope that the smelly, corrosive stuff would escape through them. There were several exhaust fans, connected by ducts to hoods, or arranged to exhaust through nozzles above manholes that were opened occasionally in the tops of "witches' brew" retorts. The large building was entirely innocent of any means for entry of properly warmed outside air.

The exhaust fans tried to do their best and succeeded frequently—if not continuously—in obtaining air for carrying off the fumes by sucking it downward through the wood chimneys and by mixing it with the fumes that the chimneys were designed to remove.

The answer here, as in the forge shop, was to provide tempering heaters and air supply fans to such

an extent as to let the exhaust fans have something into which to set their teeth. Any fan man could have advised the owner what to do—but fan men are quite busy these days, and it appears that plenty of owners are so burdened with production that the slogan still is to install some more exhaust fans.

In another very extensive chemical laboratory dealing in research concerning lethal gases, the problem seems to have been solved by providing a separate exhaust fan for every room or hood, with a very definite supply of conditioned outside air. The air supply system first builds up a positive pressure in the hundreds of feet of corridor, and second, furnishes into every room at slightly less than normal atmospheric pressure enough air to supply the air removed by the exhaust fans, while also insuring that these exhaust fans shall always attempt to remove somewhat more air than that which may enter the room. To this end, automatic static air pressure regulators were installed at each exhaust fan, and the room construction was sealed as nearly airtight as possible.

Here is an example of the application of nearly balanced draft to ventilation, a principle well understood and long applied in boiler combustion control.

NAFM DEFINES TYPES OF FANS →

The National Association of Fan Manufacturers has recently published Table 10—Names and Definitions of Types of Fans, Supplement No. B to Form X-12. This copyrighted table is reproduced here by permission of the NAFM.

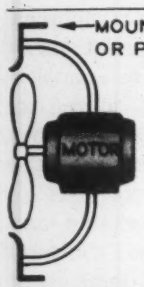
The terms "propeller" and "centrifugal" as applied to types of fans are familiar through long usage. The term "tubeaxial" is new, although applied to a type of fan which has been on the market in a slightly different design for a long time. The new name is more descriptive of the specific type and helps to distinguish it better from other designs, says the association. Likewise the term "vaneaxial" is new and is applied to a type of fan more recently offered to the public. Its use during the war has been restricted to essential Navy and industrial applications.

BOOKLET ON ASHVE RESEARCH AVAILABLE

If you want to know what projects are being studied—and what projects are planned for study—by the American Society of Heating and Ventilating Engineers, write the Director of Research of the ASHVE, 10700 Euclid Ave., Cleveland 6, Ohio, for a copy of the new booklet on research. Listing 28 projects, it describes the purpose of each, the reasons it has been or will be undertaken, and the general methods of attack.

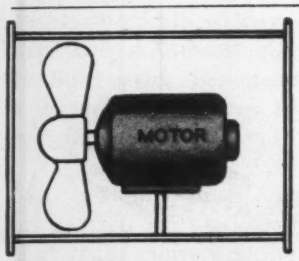
Studies are included on air distribution in rooms, air friction in ducts and fittings, projection of heated and cooled air streams, performance of barometric dampers, comfort and environment, air conditioning and the worker, shock effect in summer air conditioning, design of psychrometric rooms, analysis of codes covering heating and ventilation, weather data for design, heat transmission through windows and glass panels, heat losses due to infiltration, heat losses from basement walls, heat transfer through wetted walls, solar heat load computations, solar heat gain of insulated walls, specific heat of building materials, heat transfer coefficients of "Freon" refrigerants, cooling tower design and performance, psychrometric instrumentation, comparative analysis of psychrometric systems, air and surface temperatures in a panel heated room, measurement of the radiant effect in heated and cooled rooms, field studies of radiant and panel heating, sound energy studies, air cleaning devices, corrosion, and gravity circulation of water in a vertical pipe and turbulence due to circulating pumps.

The ASHVE will welcome your comments on these projects.



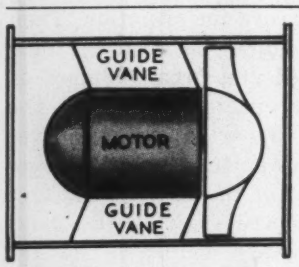
PROPELLER FAN

A propeller fan consists of a propeller or disc type wheel within a mounting ring or plate and including driving mechanism supports either for belt drive or direct connection.



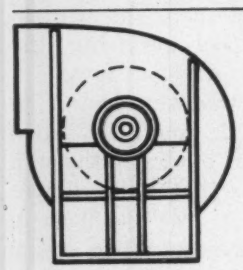
TUBEAXIAL FAN

A tubeaxial fan consists of a propeller or disc type wheel within a cylinder and including driving mechanism supports either for belt drive or direct connection.



VANEAXIAL FAN

A vaneaxial fan consists of a disc type wheel within a cylinder, a set of air guide vanes located either before or after the wheel and including driving mechanism supports either for belt drive or direct connection.



CENTRIFUGAL FAN

A centrifugal fan consists of a fan rotor or wheel within a scroll type of housing and including driving mechanism supports either for belt drive or direct connection.

MIST AND DUST COLLECTION IN INDUSTRY AND BUILDINGS

C. E. Lapple, du Pont Engineer, Reviews Methods of Analyzing Dust Particles in Fourth Article of This Important Series

"Dust is all pervasive, everywhere, on land or sea . . . in all manufacturing processes; in the smoke from our furnaces." The problem of dust and mist control and collection is constantly receiving more attention and prominence, in order to eliminate nuisances, guard health and safety, reduce maintenance of equipment, recover valuable products, etc. . . . Mr. Lapple, of the technical division, engineering department, E. I. du Pont de Nemours & Co., reviewed the purpose of mist and dust control and collection, and discussed the characteristics of mists and dusts, in the July HPAC. In August, he considered the measurement and character of atmospheric pollution, and in October, he wrote on sampling ventilation and process gases. This month, he explains microscopic and elutriation analyses of dust.

★ ★ ★ ★ ★

IN A MICROSCOPIC analysis of dust to obtain information for design of a collection system, to determine performance of an existing system, or to evaluate the need for installing a system, the particles in a given field of view are counted and classified into specific incremental size groups to obtain a particle size-number frequency distribution. To convert this to a size-weight frequency distribution, the number of particles in each size group is multiplied by the cube of the average diameter to give the relative weight in each group. The total relative weight is given by the sums of all these products, from which the per cent by weight of material in each fraction can then be computed. A typical microscopic count is given in Table 1, together with the necessary calculations, and a plot of the final analysis is shown in Fig. 1. The predominant effect of coarse particles on a weight basis is evident from the values of Table 1.

If the counted microscopic field had not been quite representative of the overall sample with respect to the coarse particles, a very large error would be introduced. To minimize this error, a larger field or a greater number must be counted to yield a greater number of coarse particles, but such a procedure results in having to count an excessive number of fine particles. For this reason it is desirable to classify a dust into specific size fractions by elutriation or sedimentation and make a count on each fraction, as suggested by L. T. Work in the Proceedings of the American Society for Testing Materials, 28, Part 2, pp. 771-812 (1928). In this way a larger number of coarse particles can be counted without having to count excessive numbers of fine particles. A composite analysis is obtained from the results on each fraction

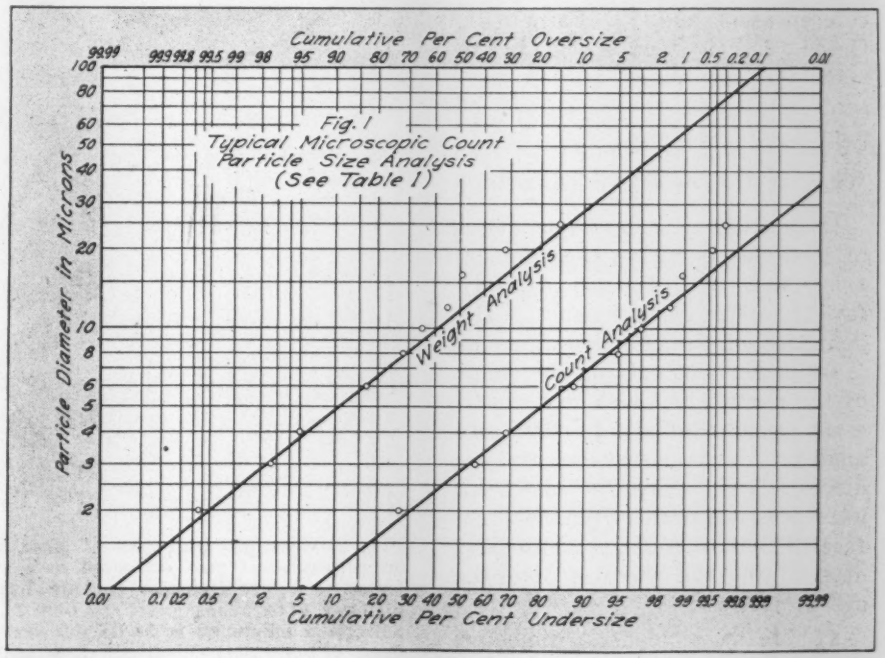


Fig. 1 Typical Microscopic Count Particle Size Analysis (See Table 1)

Table 1—Typical microscopic particle size count (see Fig. 1)

Particle Size Range Microns	Average Size of Range D Microns	D^3	Number Particles in Field n	Per Cent by Number in Range	Relative Weight nD^3	Per Cent by Weight in Range	Cumulative Per Cent Larger Than Bottom Size of Range By Number	By Weight
0-1	0.5	0.13	35	5.33	5	0.00	100.00	100.00
1-2	1.5	3.38	141	21.49	476	0.35	94.67	100.00
2-3	2.5	15.63	195	29.73	3,048	2.24	73.18	99.65
3-4	3.5	42.88	78	11.89	3.345	2.45	43.45	97.41
4-6	5	125	129	19.67	16,125	11.83	31.56	94.96
6-8	7	343	45	6.86	15,435	11.33	11.89	83.13
8-10	9	729	13	1.98	9,477	6.94	5.03	71.80
10-12	11	1,331	10	1.52	13,310	9.76	3.05	64.86
12-16	14	2,744	3	0.46	8,232	6.03	1.53	55.10
16-20	18	5,832	4	0.61	23,328	17.11	1.07	49.07
20-25	22.5	11,391	2	0.31	22,782	16.71	0.46	31.96
25-30	27.5	20,797	1	0.15	20,797	15.25	0.15	15.25
>30	....	.....	0	0.00	0	0.00	0.00	0.00
		Totals	656	100.00	136,360	100.00		

by adding the respective analysis in proportion to the weight percentage of total sample originally present in each fraction. A typical series of photomicrographs taken on samples of a zinc ore roaster dust, split into several fractions by means of screens and a pneumatic air classifier, is shown in Fig. 2.

Microscopic counts can be made directly under the microscope by using an eyepiece containing a calibrated scale. To avoid excessive eyestrain, it is usually desirable to project the image on a screen or to photograph and enlarge the image. In making a count, only the particles with sharp contours should be considered since considerable error in measured diameter may result if the particle is slightly out of focus. Meldau and Stach (12)* discuss the advantages of dark field illumination. For brief general details on the manipulation of ordinary light microscopes, the reader is referred to references 3 and 7. Fairs (5), Green (8), (9), and Work (in the reference mentioned above) present details on the technique of microscopic analyses.

What Is the Effective Diameter?

In making a microscopic count of irregular particles, the question arises as to what dimension to take for the effective diameter. The definition of the effective diameter is dependent not only on the shape of the particle but also on the ultimate purpose of the particle size analysis. Most measurements are directly or indirectly concerned with determination of particle surface. The most common methods of determining the effective diameter are as follows:

a) Mean accidental diameter. This is obtained by measuring all particle dimensions along the same direction, neglecting any of the dimensions in other directions. This method assumes random orientation so that the mean diameter should be obtained statistically if sufficient particles are measured.

b) Projected area method. In this method the diameter is taken as the side of a square or circle having the same projected area as the particle.

*Numbers in parentheses denote the references listed at the end of this article.

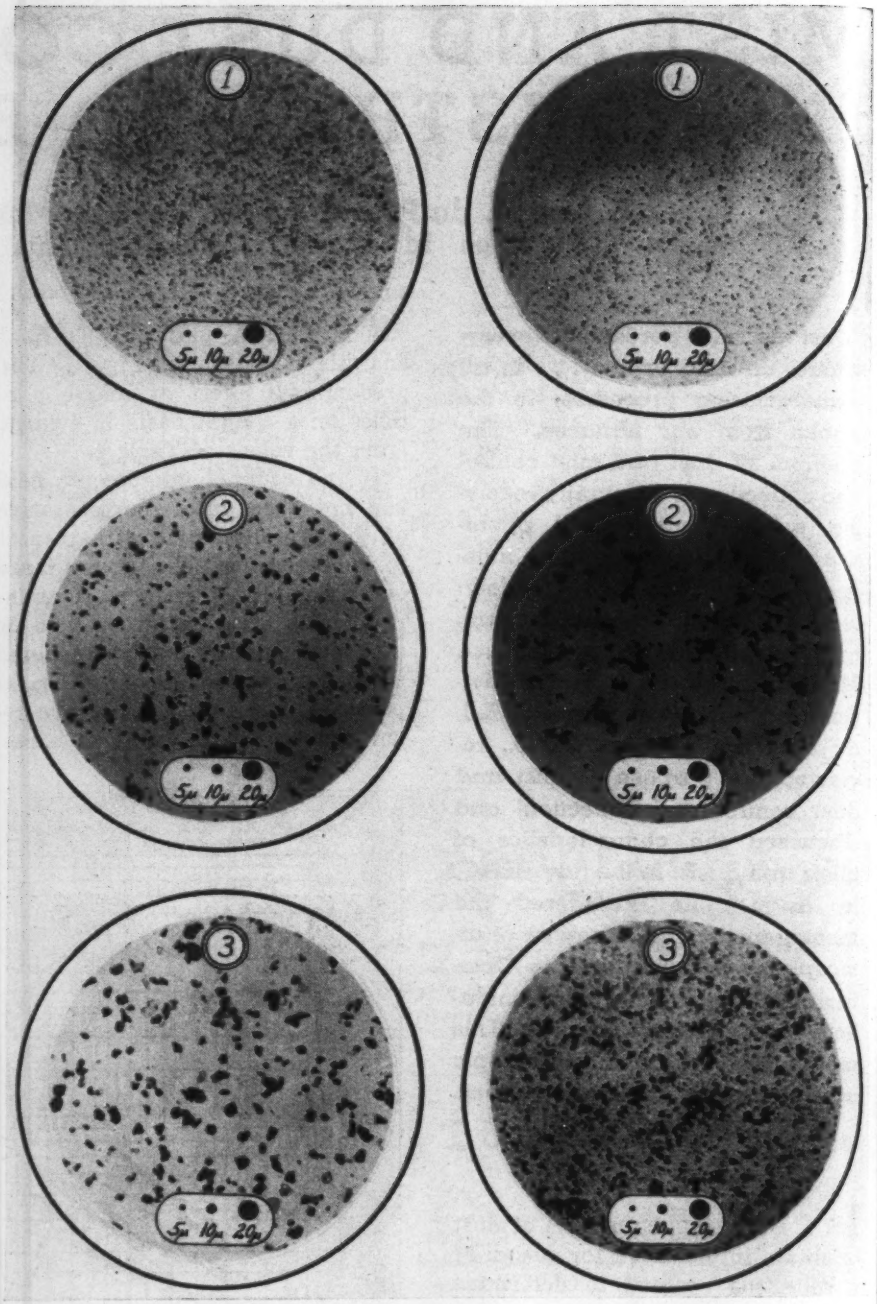


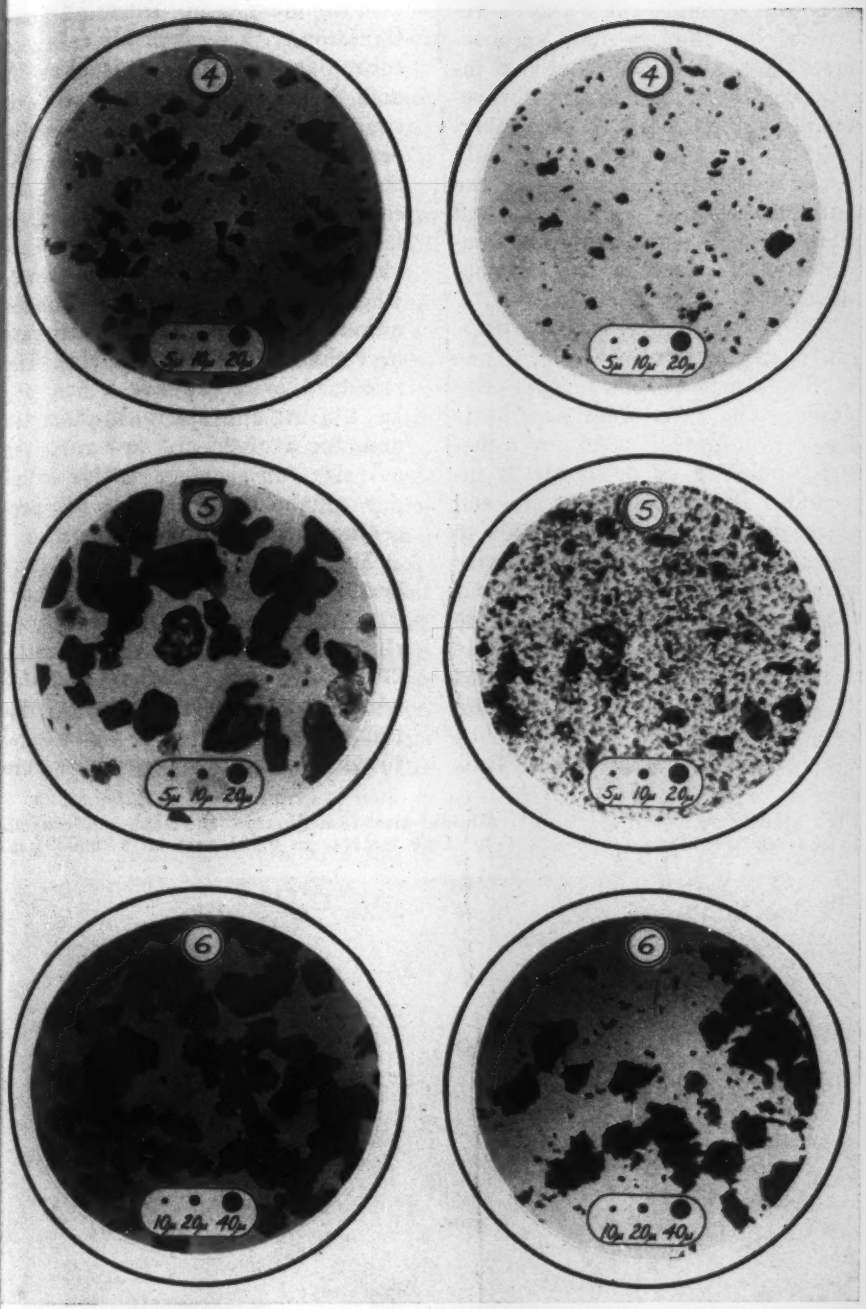
Fig. 2—Photomicrographs of dust from zinc ore roaster. These are photomicrographs of dust collected in a zinc ore roasting system. The dust is collected in a 7 ft diameter cyclone, handling about 20,000 cfm (at operating conditions) of calciner gases at 1000 F, followed by a Cottrell. The cyclone dust collection efficiency is 50-55 per cent while the Cottrell efficiency is 90-95 per cent. Photomicrograph No. 6 in each case represents the fraction of dust retained on a 325 mesh screen while the other photomicrographs represent the various fractions obtained by successive fractionation of the minus 325 mesh material in a Federal pneumatic laboratory unit. The per cent by weight of the total dust sample represented by each fraction is shown in the following table:

	Per cent in Fraction Number					
Dust From	1	2	3	4	5	6
Cyclone (left view)	12	13	22	42	5	6
Cottrell (right view)	35	28	24	11	1	1

c) Measurement of three dimensions at right angles and using the arithmetic, geometric, or harmonic mean of three dimensions as the average diameter.

d) Measurement of the minimum dimension for each particle as the effective diameter.

The first and second methods do not allow for the tendency of a particle to lie on its flattest side so that the smallest dimension is not visible in the microscope, while the third method is difficult and laborious. Work, in the reference previously mentioned, suggests



that for regular shapes the mean accidental diameter is satisfactory, but for very irregular particles, particularly flat particles, he obtained more satisfactory results by using the smallest dimension for each particle visible in the microscope on the assumption that it comes closer to representing an average between the smallest (or invisible) dimension and the largest. Shape factors have been proposed (9) but they are not usually readily obtainable nor are they always significant. For the accuracy warranted in dust control application, the mean accidental diameter or diameter of a circle of equivalent area is recommended for particles approximating regular shapes, while microscopic analysis is not recommended for flat or elongated particles.

It is not possible to resolve particles finer than about one-third the wave length of the light used. For this reason ordinary microscopes cannot be used to measure particles finer than 0.2 micron in diameter. The use of utraviolet light permits the resolution of particles as fine as 0.1 micron.

A recent development is the electron microscope (2), (4), (6), (10), (11), (13), 14), shown in Fig. 3, in which an electron beam is used in place of light. Magnetic or electrostatic fields replace the usual optical lenses and the object is made visible by photographic means. The electron microscope is capable of resolving particles as fine as 0.005 micron and some claims have been made to the effect that large molecules were made visible by this means. An upper limit of 15 microns is set purely on practical grounds since too much of the field would be covered by larger particles. In Fig. 4 is shown an electron micrograph to illustrate the detail and magnification that can be secured by this means. Green and Fullam (10) give an excellent and brief comparison of the relative advantages and characteristics of the electron and optical microscopes. An exhaustive bibliography of 496 references is presented by Marton and Sass (13) on the subject of electron microscopy.

The ultramicroscope (1), which depends on the scattering or refraction of light from strongly illuminated particles, can cover a particle size range of 0.1 to 0.005 micron. Considerable technique is required in its use and it does not show the particle directly—only the beams of light from the particle. The particles in a specific volume are measured and particle size is calculated on the assumption that the particles are spherical or cubical.

Elutriation Analyses

In elutriation analyses, materials are separated into sized fractions, analogous to those obtained with screens, by the upward motion of a fluid stream which carries with it those particles that are too fine to settle against the upward fluid velocity. In this way, a dust is separated into particle size fractions according to the settling rates of the particles. The settling rate is in turn related to particle diameter by definite laws which will be considered in detail in a later article. Of these, Stokes' law for spherical particles is probably the best known and generally applies for the gravitational settling in air or water of solids finer than about 200 mesh (74 microns). Since the particle size range of 0.1 to 100 microns is of chief interest in both

dust control application and particle size analysis by elutriation and sedimentation, most such particle size analysis methods relate the settling rates to particle diameter in terms of Stokes' law. Thus, the particle size obtained from elutriation or sedimentation analyses is that of a sphere of the same density having the same settling velocity as the particle in question.

Elutriation apparatus falls into two general groups, single and series. In series elutriators, the fluid is passed at constant rate into the bottom of vertical cylinders or cones of increasing diameter in series, the material to be elutriated being introduced at the bottom of the first and smallest cylinder or cone. In this way particles of a different size range are finally collected in each chamber, the finest material being carried over from the last and largest chamber. In the single type of apparatus, only a single chamber is used at a time to obtain a single cut which is recovered in the overflow. Subsequent cuts are then made by increasing the fluid flow rate or reducing the size of the chamber. Elutriation apparatus commonly employs either air or water for the elutriation fluid. Pearson and Sligh (20) have presented a comprehensive survey of the development of the air elutriator.

The Roller analyzer (15), (21), (22), (23), shown in Fig. 5, is one of the common single types employing air. The dust sample is placed in a glass U-bend and a metered quantity of dried air is introduced from a nozzle at one end of the bend at a velocity of 200 to 300 ft per sec. The high velocity is desired to disperse the dust but cannot be too high in order to avoid attrition of the dust. The fines are carried out of the top of the cylinder by the air stream and are collected in a paper thimble, while the coarser particles fall back into the glass bend. During a fractionation with a given air rate and tube diameter, the air is shut off and the thimble weighed at fixed time intervals. In industrial analyses the fractionation is often continued until the quantity of fines carried over during an interval is less than 10 per cent of that carried over during the first interval, whereupon the next cut is made either by increasing the air rate or reducing the cylinder size. The standard cylinders are 9 in., 4½ in., 2¼ in., and 1⅛ in. in diameter and, for a given air flow rate, the cut size for each successive cylinder will be twice that of the preceding larger cylinder.

The Gonell air elutriator (18) and the Haultain "Infrasizer" (19) are typical of the series type elutriators. The Federal pneumatic laboratory unit (17) is a device which employs air as the elutriation fluid and uses centrifugal force in place of gravity to secure

Fig. 3—An electron microscope

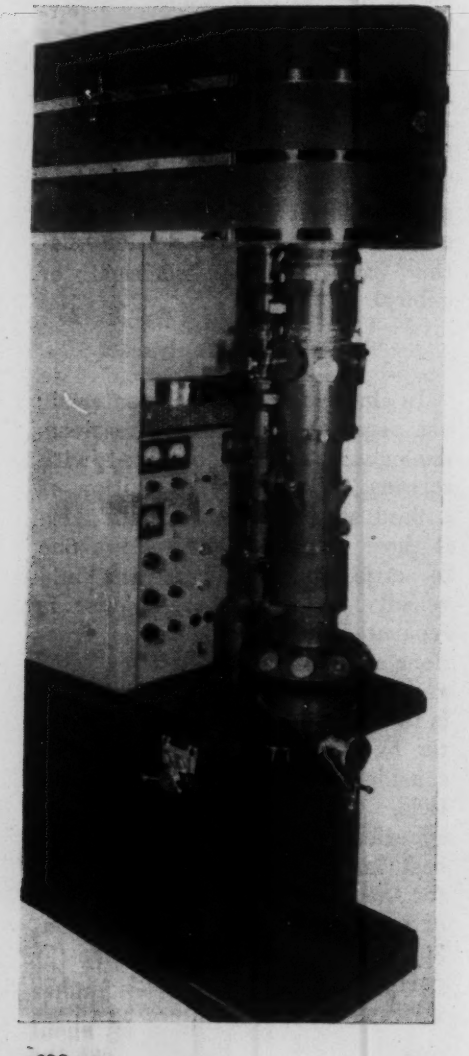
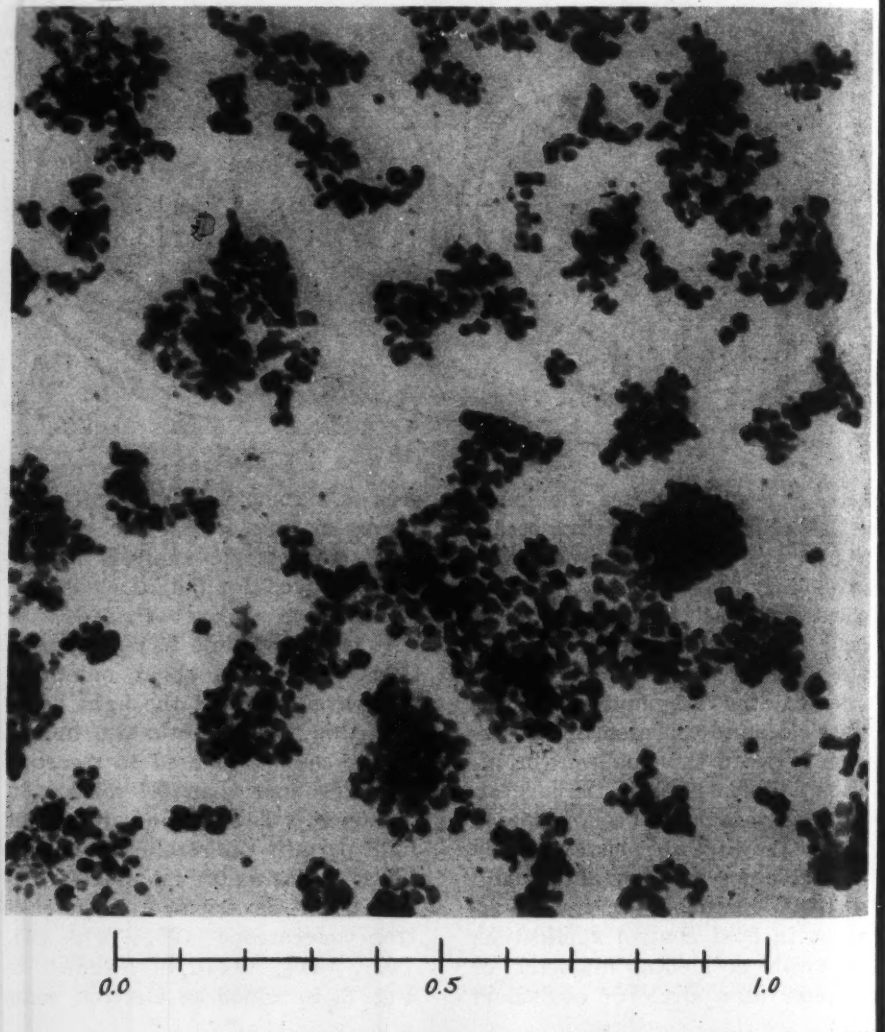


Fig. 4—Electron micrograph of colloidal titanium dioxide, the scale underneath indicating the size in microns (μ). One micron = 0.001 mm = 0.0000394 in.



separation. It does not give as sharp a fractionation as the above types but can separate relatively large amounts of material into sized fractions. Fig. 2 presents photomicrographs of dust from a zinc ore calciner that was fractionated by means of this unit.

Of the liquid elutriators those of Schöne (24) and Andrews (16) are typical of the single and series types, respectively. The former is widely used in the study of clays. Water is usually employed as the elutriation liquid, though other liquids—such as kerosene or alcohol—have been used. It is generally necessary to employ a dispersing agent, such as ammonia, sodium silicate, sodium pyrophosphate, or "Gardinol," to prevent flocculation of the particles. The choice of dispersing agent must be determined for each type of dust.

Both air and water elutriation methods are limited to a particle size distribution analysis in the range of 5 to 100 microns, with a lower limit of 3 microns on very dense materials. Air elutriation is generally more rapid for the finer sizes than liquid, both, however, requiring upwards of 6 hr for elutriation of the 0 to 5 micron fraction. For most materials a cut at 5 microns is relatively difficult unless an appreciable percentage (10 to 20 per cent) of particles larger than 20 microns are present. Air elutriation is limited by the difficulty of dispersing the fine dust, while liquid elutriation is limited by the low velocity required with small particles and the effect of thermal and density convection currents. With air elutriators, dispersion is generally achieved by a high velocity air jet, while, with liquid elutriators, this is secured by means of dispersion agents.

It is exceedingly important that proper dispersion be obtained with liquid elutriators and it is generally necessary to determine the proper type and concentration of dispersion agent to use with each dust used. Complete dispersion can generally be recognized by the appearance of suspension and can be checked by microscopic examination of the suspension. A well dispersed suspension will also give a very compact sediment while a poorly dispersed suspension will yield a loose sediment even though the sediment may form much more rapidly. Elutriation methods are inherently not capable of as sharp a cut as are sedimentation methods due to the difficulty of obtaining a completely uniform fluid velocity across the elutriation tube cross-section. This does not mean, however, that elutriation analyses cannot yield as accurate a particle size distribution analysis as can sedimentation methods since this overlap in size is generally almost self-compensating, i.e., fine particles retained in the coarse fraction are compensated for by coarse ones carried over into the fine fraction.

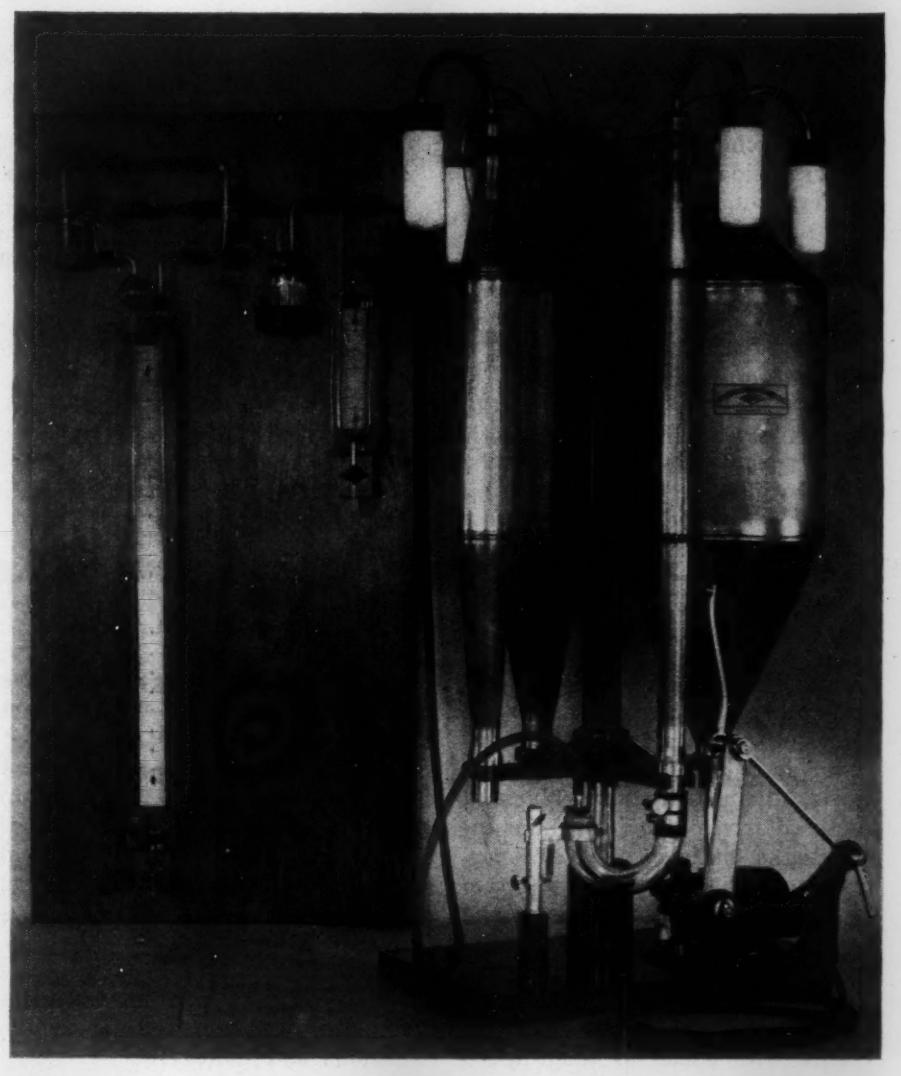


Fig. 5—Roller air elutriation particle size analyzer

[Figs. 2 and 4 courtesy of E. I. du Pont de Nemours & Co., Inc.; Fig. 3 courtesy of Radio Corp. of America; Fig. 5 courtesy of American Instrument Co.]

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THE NATIONAL FUEL EFFICIENCY PROGRAM

To COMBAT waste in burning coal and other fuel, the Bureau of Mines of the Department of the Interior, in cooperation with the Solid Fuels Administration for War and representatives of industry, has instituted a national fuel efficiency program. The aim of this program is to provide expert guidance and advice for industrial plants and buildings using fuel for heating, generation of power, or for other purposes. The program is not concerned with homes or small apartment buildings.

To obtain the greatest degree of efficiency in using fuel at an industrial plant or large building requires the skill of trained engineers who can locate escaping heat and power and recommend practical measures to adjust the faults. Many of the nation's larger plants employ combustion engineers whose jobs are to save the plant's money by increasing the efficiency of fuel use. But for every large plant that employs its own expert there are hundreds of smaller ones dependent upon firemen and engineers who have not had the benefit of special training and who must do their work without the advantages of improved and modernized equipment by which to detect and prevent escaping heat and power. These smaller plants can benefit immeasurably by taking part in the national fuel efficiency program, which offers the voluntary cooperation of engineers who will provide advice to plant managers without cost. Many of the larger plants are cooperating now in the program with fresh emphasis on fuel saving.

To assist in carrying out its fuel efficiency and conservation program on a national scale, the Bureau of Mines has appointed a National Fuel Efficiency Council of 12 men. They include smoke abatement engineers and experts from the coal, oil, and gas industries. The council works on policy matters and helps to solve special problems in certain regions and industries.

Local Coordinators, Regional Engineers, and Waste Chasers

In the field, the program for conserving fuel is spearheaded by about 200 local coordinators, who serve in the industrial centers in which they live. Each local coordinator appoints an advisory committee which may be composed of local engineering experts, industrial leaders, smoke inspectors, and representatives of such groups as the chamber of commerce, coal association, and the board of education. He also appoints regional engineers who are qualified to inspect industrial plants and buildings and make recommendations on fuel efficiency. These engineers, working without pay, contact the management of office buildings, laundries, theaters, schools, bakeries, foundries, factories and other users of fuel, and seek to obtain their cooperation in the program. The plant or building management is asked by the engineer to sign a voluntary pledge of cooperation.

When this cooperation is obtained, the plant or building management appoints a "waste chaser," who accompanies the visiting engineer on an examination of the plant. If confronted by special problems, such as those involved in heat control or special fuel utilization, they may call upon the services of experts as needed. All of this is done without cost to the plant or building.

An important feature of the national fuel efficiency program is the use of "quiz sheets" on such subjects as burning coal, oil, gas, boiler operation, and the means of saving heat and power throughout the plant or building to obtain the best results. These sheets are used by the regional engineers and the waste chasers to correct faults in operation and equipment. The sheets give expert advice.

On inspections, every use of steam, electricity, water, compressed air, gas, refrigeration, or other facility is studied in detail by the waste chaser and engineer, and by any other plant employees assigned to work out conservation measures. Many of these measures are so simple as to cost nothing save a small amount of repair work, or an added piece of insulation.

Any inquiries regarding the operating details of the national fuel efficiency program should be directed to the National Fuel Efficiency Section, Bureau of Mines, Washington, D. C.

A Designer's Notes on

Heating, Ventilating, and Air Conditioning Hospitals

Foreseeing a Big Need for New Hospital Construction and Modernization, J. G. Mench Jots Down General Comment on Requirements of Such Buildings

THERE IS A definite need for additional hospital facilities in practically every community, due to lack of construction because of wartime scarcities. Since discontinuance of construction, the normal demand has accumulated and in addition has been increased due to "hospital-mindedness" created by various insurance plans for hospital care. Thus, many organizations are contemplating new structures to replace or supersede present plants or are thinking of modern additions to increase capacity.

In view of the expected activity in postwar hospital construction, it should be appropriate to discuss in a general manner some of the more important requirements of the mechanical equipment and services to be provided.

Steam Supply

Steam supply to hospital buildings must necessarily be divided into a number of classifications due to various pressures required for the several types of uses or services.

The highest pressure required for utility use is for the laundry equipment—approximately 100 psi, or as near as possible to that. The next lower or intermediate pressure required is for the sterilizing equipment—approximately 50 psi—in order to allow for pressure drop in supply piping and still provide sufficient differential for individual regulating valves at each piece of apparatus. The next lower pressure requirement is for the kitchen equipment—approximately 25 psi—with subsequent stepdown for certain items such as kettles, steamers, etc.

The lowest steam pressure required obviously will be for the direct heating system, which may or may not include some of the numerous air heating coils installed in the ventilating systems. Many of the latter—especially those used during the summer months in connection with the special air supply systems—should logically be supplied from the intermediate pressure source, inasmuch as this supply is always available whereas the low pressure heating supply is not.

Types of Radiating Surfaces

In patients' rooms and other spaces in general (outside of the operating rooms) exposed cast iron direct radiation of the easy cleanable type is most commonly used. Convector types of radiation are often preferred for the sake of appearance, but the small spaces between fins of the heating elements present a problem demanding a solution because they are often difficult to clean—even with removable enclosure fronts—and cleaning will often be neglected, for the accumulated dirt is not readily visible as it is in the case of exposed units. In some locations, as in nurseries where beds or cribs might be placed near the heating units, the radiators should be shielded to prevent discomfort from intense radiation.

Radiant panel heating suggests interesting possibilities, aside from its installation cost in multi-story buildings, but in making a decision as to whether or not it should be used in a hospital consideration should be given to the fact that window openings occupy a very large percentage of outside wall surfaces in most modern hospital rooms. Also, providing necessary insulation in the walls back of embedded heating coils would entail considerable cost and would also require sacrifice of critical and valuable floor area due to thickening of the walls. Interior partitions are usually filled with many utility services and would require considerable thickening for embedded coils at the expense of floor area loss. Likewise, floor slabs would not be available in many areas for embedded coils, necessitating suspended ceilings for concealment of coils with the addition of coils under windows to offset the heavy infiltration loss encountered in this class of buildings.

Operating rooms require special handling of the heating problem in order to avoid dust catching and dust circulating apparatus. In many cases it has been the practice to install exposed radiators, which usually are found to be completely enclosed in cloth sheets, thus reducing the dust circulation problem but interfering seriously with heating capacity. The most modern type of construction for such rooms consists of double walls with radiation installed in the air space between, thus warming the room by a form of radiant surface. On account of the high humidity maintained in operating rooms, it is necessary to provide a moisture seal on the inner surface of the outer wall and also to employ double glazing of windows.

Types of Heating Systems

The type of system selected may be either low pressure steam or forced hot water, depending upon the size of the building and the preference of the designer for the particular case under consideration. Each type has certain advantages and this article does not presume to suggest one over the other. The most important feature to be emphasized is provision for zoning of any system and temperature control of the heating medium in accordance with outdoor conditions.

Air heating coils preferably should be supplied with steam in

lieu of hot water on account of exposure to freezing temperatures in systems requiring 100 per cent outdoor air intake at all times that they are in operation.

All apparatus supplied with steam (except vegetable steamers and similar equipment) will require suitable traps, adapted to each particular supply pressure, for release of condensate and entrained air into properly designed return mains. For satisfactory operation of the steam heated equipment, the return mains must be free from sealing pockets to insure open venting to atmosphere and prevention of back pressure. These intermediate pressure returns are usually run into a condensation receiver and thence discharged to the boiler or feedwater heater by means of condensate pumps. The heat contained in flash steam and high temperature condensate can be reclaimed by passing it through tempering coils placed in the lower portions of the domestic hot water generators.

The heating returns must obviously be vacuum type with pumps suitable for developing sufficiently low pressure to insure drainage of radiators under all conditions of steam supply as regulated by the temperature control system.

Calculations for the required heating surface in hospitals are handled in the ordinary manner except that allowance must be made for additional infiltration caused by ventilating systems due to preponderance of exhaust over supply. This excess of exhausted air places the building under negative pressure and acts to increase the normal amount of infiltration ordinarily assumed. The amount of this excess is variable, depending upon the number of window and door openings and the total excess of exhaust over supply.

Ventilation

All patients' rooms are normally provided with natural ventilation, as specified in building code requirements similar to those for living quarters, and hence need not be included in a discussion of ventilation requirements, except insofar as comfort air conditioning is concerned.

All other habitable spaces not provided with adequate window openings must be furnished with air supply and exhaust in accordance with use or occupancy, special attention being given to operating, delivery, anesthesia and sterilizing rooms, nurseries, necropsy rooms, x-ray departments, laboratories, kitchen, laundry, and machine rooms. All inside toilets and utility rooms must be provided with positive exhaust and such exhaust is advisable for similar outside rooms even if they are provided with windows.

Generous amounts of ventilation are most desirable in hospitals in order to prevent dissemination of odors and to remove excessive heat in many locations. Furthermore, dilution of anesthesia gases and vapors below points of certain concentration is essential to the prevention of explosions. Anesthesia gases are heavier than air, requiring the greater part of the exhaust to be drawn through openings near the floor.

Air Conditioning

Comfort air conditioning for entire large hospital buildings is not at present generally feasible from the viewpoints of installation cost and operation expense, for if provided it might make room accommodations too high priced for most patients.

Certain areas, such as surgical and delivery departments where dangerous gases are employed, require accurate control of humidity for safety of patients and personnel, and the control of temperature is obviously related thereto. The ancient practice of maintaining extremely high temperatures in operating rooms with the idea of keeping the patient warm during an operation has been generally superseded by the present practice of maintaining a lower temperature more suitable for comfort of the operating personnel, without being detrimental to the patient.

Inasmuch as a continuous supply of air and continuous exhaust, without recirculation, must be provided both in summer and winter, a complete system of year around air conditioning is indicated, including filtering, heating and/or cooling, and humidifying of the air supply. Proper humidification is very important in conjunction with other factors in prevention of static sparks and consequent ignition of the highly flammable anesthetic gases or vapors.

Provision for cooling during periods of high outdoor temperature provides much desired comfort for patient and personnel and relieves fatigue of the latter from the exacting work involved.

In addition to the surgical areas above mentioned, it is highly desirable to provide recovery rooms with temperature and humidity conditions similar to operating rooms where patients may be kept for several days after an operation, thus reducing possibility of postoperative pneumonia and assisting in recovery from shock.

The refrigeration requirements of hospitals fall into two general classes, low and high temperature. Low temperature refrigeration includes ice making, ice storage, drinking water, ice cream making, and food storage. High temperature refrigeration includes mainly the air conditioning load, although the two systems may be interconnected through a heat exchanger in order to provide transfer of capacity between the two systems during periods when only light cooling capacity might be required. Cooling coils of the air condition-

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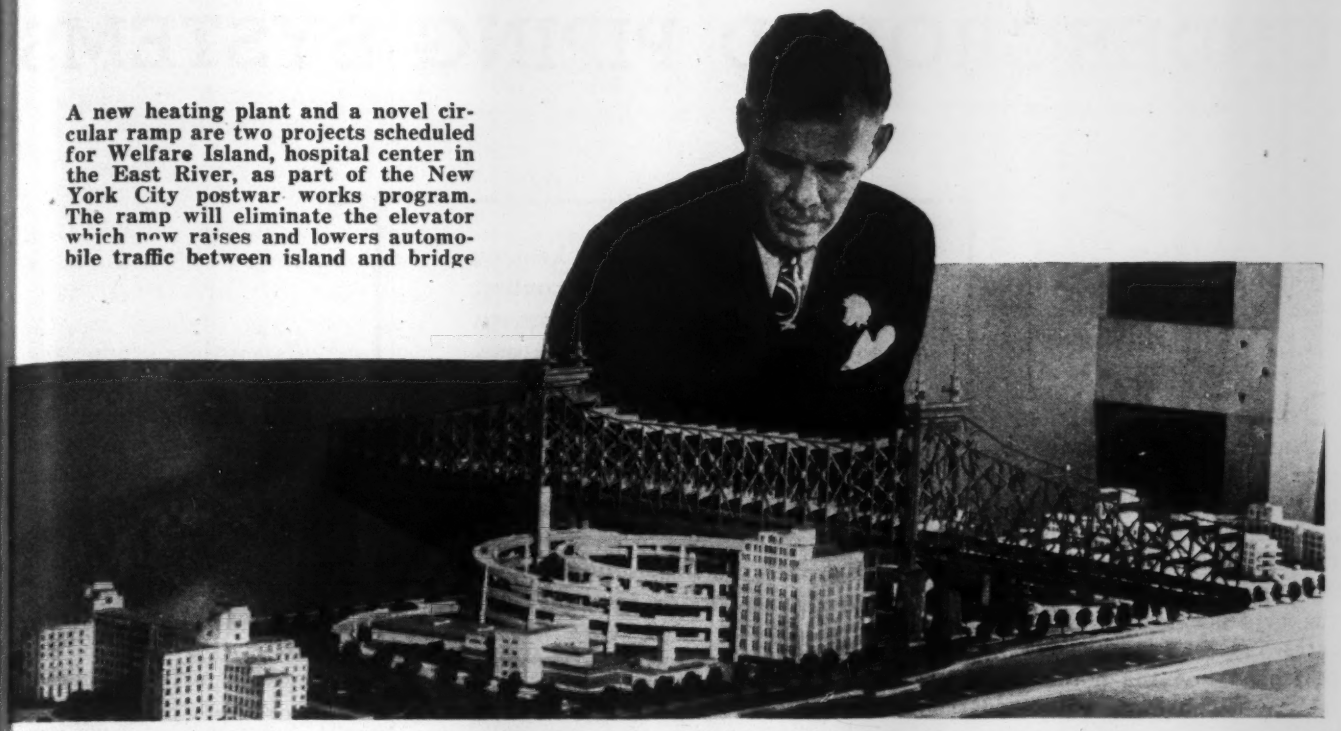
Of most importance to all concerned in the operation of a hospital is safety from accidents and freedom from infection of patients and personnel. These hazards can be minimized by proper ventilation, including filtering, and by sterilizing and humidity control—and by proper installation of explosionproof electrical wiring systems and constant vigilance over the safeness of the equipment used . . . In this article, Mr. Mench—who is now with James Stewart Corp., engineers and contractors, and who was formerly associated with Thielbar & Fugard, the architects, in the design of the mechanical and electrical equipment for Wesley Memorial Hospital, completed just before the war—has set down some general comment from his experience in the heating, ventilating, and air conditioning requirements of hospitals.



A new heating plant and a novel circular ramp are two projects scheduled for Welfare Island, hospital center in the East River, as part of the New York City postwar works program. The ramp will eliminate the elevator which now raises and lowers automobile traffic between island and bridge

ing systems must be supplied with chilled water, since direct expansion coils cannot be used in installations where helpless patients would be exposed to refrigerant gases in case of leakage or breakage.

Ventilation air quantities required for operating rooms vary according to the toxicity and explosiveness of the anesthetic gases employed, but should be not less than 20 cfm per person or approximately 12 changes per hour in order to provide dilution of vapors below ignitable concentrations and also below the point where operating room personnel would be affected. Maintenance of a relative humidity of 60 per cent in operating rooms is also advised to reduce the explosion hazard.

It is difficult to evaluate the relative hazards associated with the several combustible anesthetics. Each has its own individual characteristics: ether, for example, disperses slowly and may flow along the floor to considerable distances from the point of use and frequently has been known to form a virtual fuse from a wall receptacle arc to the operating table. Cyclopropane, on the other hand, disperses rapidly and is seldom found in dangerous concentrations at distances of more than 1 ft from the patient's mask. However, cyclopropane is frequently used in sufficiently high concentrations to result in explosions when ignited.

The anesthetics most frequently involved in explosions are ether, ethylene, and cyclopropane, although the hazard may be reduced by mixture with helium or other inert gases. Nitrous oxide and chloroform are not combustible, although the former can form flammable mixtures with ether or with hydrocarbons.

Of most importance to all concerned in the operation of a hospital is safety from accidents and freedom from infection of patients and personnel. These hazards can be minimized by proper ventilation, including filtering, sterilizing, and humidification control; also by proper installation of explosion-proof electrical wiring systems and constant vigilance over the safeness of operating room equipment.

RAILROAD AIR CONDITIONING MOST DESIRABLE FEATURE

The New York Central System, in a questionnaire survey on postwar railroad coaches, found that the total vote showed air conditioning in first place as a desirable feature; men rate it as the most important, women rate it second.

It was also found that the majority of the passengers like the temperature in the car "just as it is." This is readily understandable since the median temperature in the coaches during the survey was 74 F, which compares favorably with the 72 F median temperature the passengers prefer at home in the wintertime and the 70 F minimum (median) they prefer in the coaches during cold weather.

In very warm weather, the majority said they were willing to have the temperature varied according to that outside.

THREE ASSOCIATIONS ELECT PRESIDENTS

Warren D. Lewis, chief engineer and building superintendent of the Hotel New Yorker, was elected president of the National Association of Power Engineers at the 61st annual meeting of the NAPE held in St. Louis. Mr. Lewis was the author of two articles on hotel air conditioning published in the June and July 1940 issues of HPAC.

* * *

Walter A. Meyer, Allis-Chalmers manager of dealer sales, was recently elected president of the Multiple V-Belt Drive Association.

* * *

J. French Robinson, president of the East Ohio Gas Co., Cleveland, was elected president of the American Gas Association at the annual business meeting held last month.

UNDERGROUND PIPING SYSTEMS

Adequate provisions for keeping ground water out of the conduit, or for removing it without damage to the internal structure, are essential in the design and installation of underground steam or hot water distribution systems, says B. M. Conaty, vice-president of American District Steam Co. Where bad water conditions are known to exist, it may be necessary to place the piping above ground level

DESIGN AND installation of underground distribution systems for hot gases and fluids (such as steam and water) to produce long years of efficient service is a complicated problem and the evidence to date indicates fairly conclusively that many of the natural factors which must be considered in the design have been overlooked, with the result that installations have failed or become inefficient in all too short a period of service.

The basic components of an underground steam distribution line include a pipe which will conduct the gas or fluid, properly supported, so that it will retain its alignment and be so graded that it may be drained effectively of condensate or moisture accumulating within the line; an insulating medium surrounding the pipe which will be fairly resistant to permanent damage from moisture and occasional submergence; and a surrounding conduit which will properly support the earth and surface loads imposed on the structure and will remain impervious to moisture or be of such construction that ground water may be kept out of the conduit, or if it enters, be removed from the conduit without damage to the internal structure.

Various methods have been used to meet these requirements, and in many cases extremely satisfactory operation has resulted. But it must be recognized that in many other cases complete failure has resulted in periods much shorter than a normal depreciation period for a structure of this type. Cast iron conduit under adverse water conditions has been used in eastern cities, and in one case a high pressure steam feeder line through an area subject to tidewater is encased in a carefully designed cast iron conduit which, after more than 10 years of service, is known to be practically waterproof, though facilities are incorporated in the design for the immediate removal of any water which accumulates. In another eastern city, cast iron conduit has been used with much less satisfactory results though, with sump manholes and first class facilities for the removal of water which leaks into the conduit, the system has been in service for several years. These installations should not be confused with cast iron conduit which is provided as a means for carrying heavy earth or surface loads with no particular effort made toward waterproofing.

Under a situation where a steam line is installed in favorable soil conditions without the hazard of flooding, the several conventional forms of conduit have rendered excellent service. There are many installations of low pressure systems where wood casing has been used as insulation and conduit, and of these there are a variety of installations where more than 30 years of satisfactory service has been obtained. Similarly, reinforced concrete conduit has been used in city streets for many years, and where the drainage conditions are favorable, good service is being obtained from the systems. Repeated attempts have been made to waterproof reinforced concrete ducts, these not always proving entirely satisfactory. The reinforced concrete conduit is subject to temperature stresses due to temperature differences within the structure, which cause openings through the conduit particularly at the construction joints between the base and sidewalls, or if the base is monolithic with the sidewalls, between the lower portion of the structure and the top. These structures have been made satisfactory by providing facilities within the conduit for drainage to sump manholes and pumping equipment through which the water is removed to adjacent sewers.

During the war construction period a great many installations of underground lines have been made where all too short a period of time was available for the engineering of the work. In many cases these lines have been installed in outlying areas where sewer systems were not available and where full information concerning the ground water conditions was not to be had. As a result, these lines have been subject to spring and fall floods, which have submerged the lines and resulted in the complete failure of the insulating material. Some of these lines are supposedly waterproofed, but actually in many cases water has entered the conduit, thereby causing almost immediate failure of the insulating medium. Some of these lines could have been substantially improved had adequate underdrainage and sump manholes with pumping facilities been provided adjacent to them. Many of the difficulties encountered in locations where bad water conditions were known to exist could be solved only by expensive construction underground, but could have been made service-

able had the lines been placed above the ground.

Insulation to Withstand Ground Water Conditions

The weakest part of the underground distribution structure is the insulating medium. In order to obtain light weight material, which is required for insulation, material strength must be sacrificed, and unfortunately most of the conventional insulating materials are not of a nature which permits them to withstand water, particularly when the water is in contact with a hot pipe, which produces boiling and the equivalent of mechanical agitation in the insulation. Conventional practice where molded insulations are used has been to use waterproof jackets sealed around the insulation. This tends to increase the damage to the insulation under the submerged condition where the lines must be maintained hot, and in one case a wire-inserted asbestos jacket which admits the water and at the same time permits water to flow from the main body of the insulating material, has been used with some success.

In several cases under very adverse ground water conditions, a light weight cellular concrete material with a specific gravity of approximately 0.3 has been used successfully. This material will partially absorb water in the cell wall structure but the insulating value of the material, while reduced when wet, is restored when the material is dry. Such a material is poured in a fluid state into any conventional form of conduit and appears to impart to the structure long life under adverse water conditions. It would not be recommended for an underground condition where the installation was below normal ground water level, but is recommended for use under conditions where periodic adverse water conditions exist in the spring and fall. During these periods the efficiency of the line is substantially reduced due to the wetness of the insulation, but following the recession of the water conditions, the material dries and its efficiency returns.

Speaking generally, the best engineering practice on underground steam lines is to avoid, if at all possible, unfavorable underground water conditions. Where these unfavorable water conditions are seasonal and of short duration, good drainage and adequate pumping facilities should be provided to prevent the accumulation of water in the structure. Where the conditions are such that the line is under the normal ground water level and cannot be located elsewhere, watertight conduit with proper drainage facilities can be designed to meet the condition.

Cast iron conduit with alternate flanged and expansion ends. The flanged ends are anchored, and the other ends move into stuffing boxes

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SIMPLIFICATION OF DUCTS AND FITTINGS PROPOSED

A proposed Simplified Practice Recommendation for Pipes, Ducts, and Fittings for Warm Air Heating and Air Conditioning has been submitted to all interests for acceptance, according to an announcement of the division of simplified practice of the National Bureau of Standards. The proposal contemplates a voluntarily established stock list of pipes, ducts, and fittings representing the best thought of the industry, its distributors, and customers as to what constitutes desirable practice.

Fittings for both gravity and forced air heating and air conditioning systems are covered, the former including double-wall pipe and fittings. Sketches illustrate the 91 types of fittings, various sizes of which are included in the proposed list.

There is a total of about 1223 items in the proposal, whereas at least one large producer has recently cataloged not less than 5580 varieties of pipes, ducts, and fittings for the same types of installations covered by the proposed recommendation. On the basis of information submitted by manufacturers when the division was cooperating with the War Production Board on this subject, it is estimated that the recommendation would, if generally adopted, effect a reduction of inventory of about 40 per cent.

A limited number of mimeographed copies of the proposed recommendation may be obtained without charge from the National Bureau of Standards, Washington 25, D. C.

Air Conditioning's Wartime Job Spurs Wide Interest in Postwar Applications

T. W. Reynolds Reviews the Restrictions Due to Wartime Scarcities Which Have Had to Be Met by Installations

AIR CONDITIONING has been so intimately involved in production of military equipment and in so many other wartime operations that it should be of interest to review some of the restrictions on the installation of air conditioning and ventilating apparatus, and to indicate how it has been attempted to balance the need for air conditioning and ventilating services against the critical materials which must be utilized to obtain these advantages. It is of particular note that control of the air in industry —and in many other types of buildings and spaces—has contributed greatly to the war effort, and that the job has been done despite the handicap of many scarce or unobtainable materials due to shortages caused by the greatest conflict in the world's history. Certainly, wartime experience with air conditioning has done much to create the wide interest now being evidenced in its peace-time use in factories, office space, and many other buildings—an interest partly indicated by the considerable number of surveys and studies being made by industrial and business organizations who are making their decisions now on the extent to which they will employ controlled atmospheric conditions, and the types of equipment they will install, for their postwar operations.

Applications of equipment for control of temperature and/or humidity or for ventilation have been limited during the war by governmental orders and reviews of specific cases; however, the record of installations has shaped up to a policy which may be stated somewhat as follows:

Physical comfort alone has not generally been a sufficient justification for the use of air conditioning even in the hottest of climates, nor has increased efficiency of personnel as obtained by air conditioning in itself been considered of sufficient value *in wartime* to warrant the use of the critical materials involved. The use of air conditioning or ventilation has been pretty much confined to absolutely essential requirements of the war with the most simple type of system suitable for the service required. Such systems, for other than process requirements, have been confined generally to that part of the United States lying above a mean July temperature line of 75 F for hospital applications, and 80 F for non-process installations.

"WAR WORKER"

It is quite generally recognized that experience with air conditioning as a wartime production aid has created great interest in the wider application of this service in industry and large buildings in the peace-time years to come. That there is such interest is evidenced by the number of studies and surveys now being made by industrial and business organizations planning for their postwar operations. Mr. Reynolds, who has been very closely concerned with the subject, reviews here the wartime restrictions which have had to be met because of shortages of critical materials, and how it has been attempted to balance the use of scarce materials against the need for controlling atmospheric conditions. (Perhaps it is not amiss to mention here, parenthetically, that when judging the performance of any specific wartime air conditioning installation, it should be remembered that some war necessity or restriction, or a lack of skilled operating personnel, may have adversely affected the results achieved—a situation which will not hold true in the future).

In some cases it has been found that evaporative cooling with capillary air washers, with their low water and head requirements, use less critical materials and give more cooling than mechanical ventilation where large volumes of air must be moved—particularly so where well water is available at, say, 60 F or lower. Such washers have been found acceptable where low outside humidities make them more efficient as coolers than in high humidity climates, where air must be filtered, or where cooling by existing mechanical ventilation is insufficient for increased production schedules.

Evaporative comfort coolers have been allowed in the desert regions of the southwest where climatic conditions justify their use, though only for certain hospital spaces and for sleeping quarters for personnel whose duties require them to work continuous periods of night duty and sleep during the day. The hospital spaces in mind are wards, recovery rooms, surgeries, x-ray rooms, clinics, dispensaries where operations are performed, and patients' mess halls.

Air conditioning has been allowed only to the extent made mandatory by functional requirements or manufacturing and product processing procedures where essential for the control of temperature and/or humidity. In Army installations, such places include gun and armor plate plants (due to the necessity for insuring uniform charges for proof testing), bombsight storage, celestial navigation trainer and Link trainer spaces, Jam Handy and instrument trainer buildings, low pressure chambers, main air traffic control towers, in underground fortifications in plotting, switchboard rooms, mine casemates, command posts and sea coast battery service magazines, in those spaces in photographic laboratories and reproduction plants

where required for processing and storage of materials, and for hospitals in surgeries, x-ray rooms, surgeons' clinics and recovery rooms. Air conditioning has also been allowed in research laboratories, constant temperature rooms, parts of blackout buildings where machines of close tolerances are manufactured, wherever precision instruments are inspected, repaired and adjusted, and where required to insure accuracy in fine machine work, and in the manufacture of precision instruments and optical elements. Crane cabs which travel over factory areas where intense heat, smoke, or fumes are liberated have also been air conditioned.

Air conditioning where allowed has not been used generally throughout a building, but rather only in partitioned-off, insulated spaces where the process requires air conditioning, and then only to the degree of cooling or humidity required by the process. It has been desirable to provide windows with awnings, exterior shades, or venetian blinds, to reduce the sun heat load. Skylights have been painted or insulated, air recovery systems have been used for exhaust systems, and odor and fume adsorption apparatus has been used wherever applicable for recirculation of exhaust.

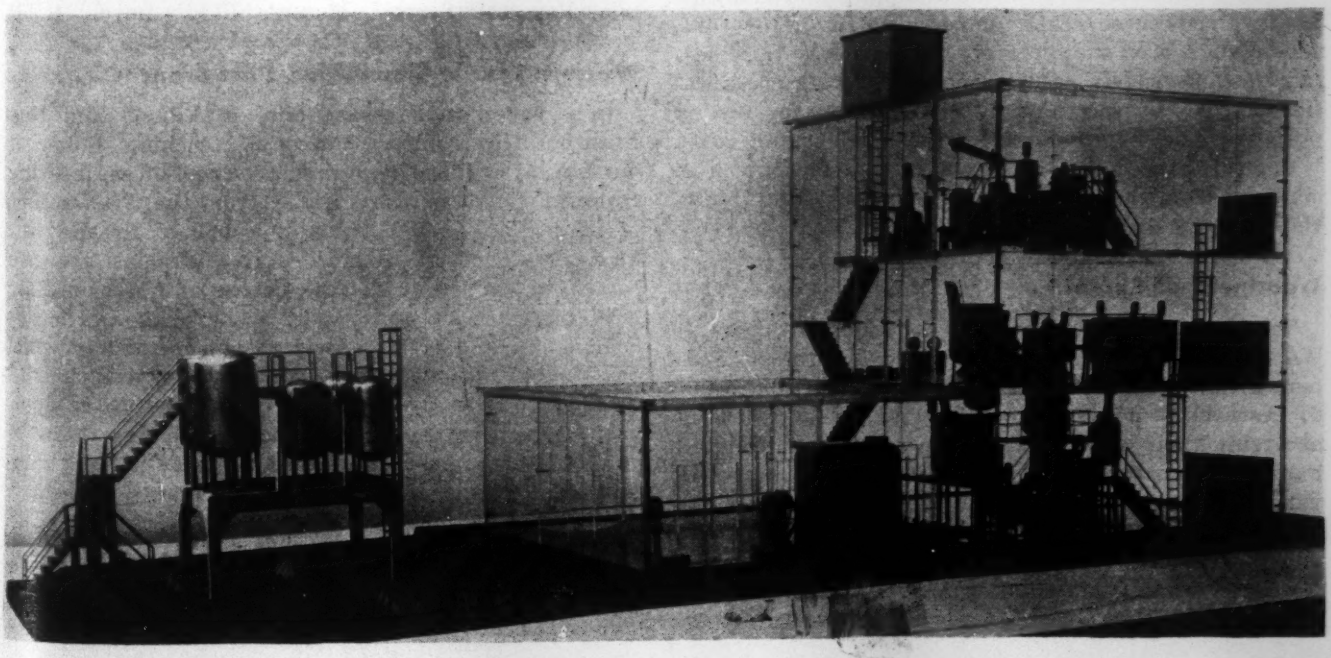
Mechanical ventilation has been allowed for hospital spaces, for permanently blacked-out buildings or spaces, and for special process spaces. In general, a building without windows or with windows with permanent closures which cannot be opened or removed for ventilating purposes has been considered a blacked-out building, and one with lightproof shades or other temporary expedients has not.

Ventilation has been allowed for basements below grade and well occupied, interior windowless spaces or the interior areas of very deep or wide spaces, especially so where there are very low ceilings in hot climates or windows only on one side or high up and abbreviated—spaces which are in effect blacked-out and require ventilation. In some cases it has been decided that blacked-out buildings have had no need of ventilation other than that already provided by process exhaust direct from machinery or furnaces, or in other cases where there are many large doors which remain open in the summer months for the passage of planes or for other reasons.

Air conditioning has not usually been allowed where cooling by fan or by evaporation would suffice, and evaporative cooling has not been allowed if the necessary results could be obtained by mechanical ventilation; and not even mechanical ventilation has been allowable if gravity ventilation would serve the purpose. Where forced ventilation has been allowed, ductwork has been nonmetallic insofar as possible. Ducts of sheet metal have sometimes been necessary where nonmetallic material would be affected by certain acids in fume removal, or where such material may become objectionable due to other process requirements.

TRANSPARENT PLASTIC USED TO VISUALIZE PLANT LAYOUT

The problem of visualizing plant layout and location has been effectively surmounted by Display Studios of Pittsburgh with the use of transparent plastic models. The synthetic rubber factory illustrated here, constructed to scale for the Blaw-Knox Co., is an example of many such plant models designed and built in this way. The walls, floors, and partitions of the model are made of "Plexiglas," a transparent plastic used for the familiar bomber nose and other aircraft enclosures. Construction of even the most intricate mechanical models for study or demonstration is said to be simplified with the use of this plastic, for not only can it be cut to size with ordinary saws but drilled and machined like soft metals. (Photograph courtesy of the Rohm & Haas Co.)



NEW BOOKS & REPORTS

Automatic Control Engineering

Automatic Control Engineering, by Ed Sinclair Smith, research engineer, Eclipse-Pioneer Div., Bendix Aviation Corp., is the first book of its kind to appear in English. It contains a clear and detailed discussion of the principles that govern the operation of controls. The author does not attempt to give a description of actual controls except as they are needed to illustrate basic principles, nor does he give details about the application of controls for typical installations. His book is intended more as a basic exposition of control principles.

Although the first few paragraphs do not employ mathematics, the language in which the material is presented is definitely the language of mathematics and physics. Furthermore, the remaining chapters rapidly delve into the differential equations needed to take account of the various transient conditions that determine the stability and sensitivity of control apparatus. For those who have the necessary mathematical background, this book will provide a good deal of valued and interesting information. Although the application of mathematics to transient conditions in the field of electricity is a long established practice, the application to mechanical problems such as those dealing with controls is relatively recent and for this purpose alone the book is well worth reading. It is very definitely a fine contribution to the science of control.

The publisher is McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. There are 367+xiii pages, 5¼ x 8¼ in., and the price is $4.00.—*W. G.*

Standards on Coal and Coke

The September 1944 edition of the compilation of ASTM Standards on Coal and Coke includes five specifications, 24 methods of testing and evaluation, and six definitions. A major portion of the standards relates to coal, with methods covering sampling and analysis, fineness (powdered coal), grindability, etc.; for coke, tests include drop shatter, sieve analysis, etc. Specifications include widely used standards covering classification of coals by rank and by grade, sieves for testing purposes, and requirements on gas and coking coals.

Copies of this 132 page, 6 x 9 in. compilation can be obtained from the American Society for Testing Materials, 260 S. Broad St., Philadelphia 2, Pa., for $1.50.

Treatment of Experimental Data

Treatment of Experimental Data, by Archie G. Worthing, University of Pittsburgh, and Joseph Geffner, Weirton Steel Co., is a book of considerable value to research workers who deal with the problem of analyzing their experimental data in order to draw reliable and trustworthy conclusions. Though more advanced than usual texts on this subject, the material is presented in such a thorough, well organized manner and is so clearly set forth that it can be used by any research worker who has an ordinary mathematical background. Much of the material has heretofore appeared in widely scattered sources; this book not only gathers this material in one volume, but treats it from a unified viewpoint.

There are 13 chapters. The first deals with the various problems involved in the representation of data by tables. The second deals with representation of data by graphs, and the third with the representation of data by equations. These three chapters in themselves offer so much illumination on the analysis of experimental data that they alone would be worth the price of the book to research workers.

The balance of the chapters cover more specialized problems in the treatment of data. Chapter 4 deals with tabular and graphical differentiation and integration. Chapter 5 deals with Fourier series, a subject that is more likely to be of interest to electrical engineers than to mechanical engineers except for those concerned with vibration problems. Chapters 6 to 8 deal with the application of statistical methods to the analysis of data. All of the various approaches to the problem of sifting test data are not only presented in detail but, what is equally important, presented clearly. Chapter 11 deals with the application of the method of least squares to experimental data.

The publisher is John Wiley & Sons, 440 Fourth Ave., New York, N. Y. There are 342+ix pages, 6 x 9 in., and the price is $4.50.

Conversion Factors and Tables

Between the covers of Conversion Factors and Tables (by O. T. Zimmerman, professor of chemical engineering, University of New Hampshire, and Irvin Lavine, formerly professor of chemical engineering and head of the department, University of North Dakota) are presented a list of abbreviations, a listing of definitions and fundamental values, and 198 pages containing over 6000 conversion factors. In addition, there are conversion tables for temperature, pressure, specific gravities, viscosity, and other engineering data. This book is, therefore, definitely a time-saver.

In convenient pocket size, 4¼ x 6 in., there are 262 pages, and the price is $2.75. The publisher is Industrial Research Service, Masonic Bldg., Dover, N. H.

Pressure Loss in Elbows and Duct Branches

In a paper on Pressure Loss in Elbows and Duct Branches, by Andrew Vazsonyi, teaching fellow in mechanical engineering, graduate school of engineering, Harvard University (reprinted from the Transactions of the ASME as publication No. 388 of the Harvard graduate school of engineering), formulas are presented which permit the calculation of losses in many duct branches by reasonably accurate correlation of sparse test data. The author gives a method by which the number of curves required to present experimental data can be greatly reduced, and the method is applicable to many other configurations, including diffusers.

This paper comprises 7 pages, 8½ x 11 in., and there is a bibliography of 39 references, many of them to foreign publications.

[*Reviews of other books and reports of interest to those concerned with the heating, piping, and air conditioning services in industry and large buildings are given on page 186 in the back section of this issue.*]

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

51st Annual Meeting in Boston

THE INVITATION of Massachusetts Chapter to be host for the 51st Annual Meeting of the Society was accepted by the Council, and the Hotel Statler, Boston, has been selected as meeting headquarters. The meeting dates are January 22-24, 1945, and at the October Council meeting approval was given to the program which will consist of four technical and business sessions, at which it is planned to present 11 papers.

The following schedule of events has been announced by the Meetings Committee, of which Dr. C.-E. A. Winslow is chairman: January 21—Council and Committee Meetings; January 22—Registration, Committee Meetings, Chapter Delegates Conference, opening Session; January 23—Morning and Afternoon Technical Sessions, and Annual Dinner in the evening; January 24—One Technical Session, Council and Committee Meetings.

The Massachusetts Chapter has selected Earl G. Carrier as General Chairman of Arrangements, and the Vice-Chairmen are James Holt and David Archer; Advisory Chairman, W. T. Jones. The chairmen of the various committees are: *Banquet*, G. B. Gerrish; *Finance*, J. W. Brinton; *Transportation*, F. R. Ellis; *Publicity*, A. C. Bartlett; *Entertainment*, C. M. F. Peterson; *Ladies*, A. L. Hesselschwerdt, Jr.; *Reception and Registration*, P. A. Croney.

Members of the Massachusetts Chapter look forward with pleasure to the arrival of Society members and guests from all parts of the United States and Canada who will attend this meeting.

A sincere welcome and New England's famed hospitality await the visiting members. Boston offers not only the memories of the past to be seen in historic landmarks, but also a busy commercial and civic life typified by the variety of industrial plants. Boston was first settled in 1630, and it abounds with places of historic interest, among the best known being Boston Common, Faneuil Hall, Bunker Hill Monument, Old North Church, Plymouth, Concord, and Lexington. It is a leading port with a magnificent harbor.

Boston is a large publishing center, a producer of fine papers, a shoe and leather center, a large cotton

Business skyline of Boston with Public Garden and Boston Common in foreground

manufacturing area, to mention just a few of its industries.

The city is a center of culture, with its fine libraries, art galleries and universities.

Registration for the meeting will be on the mezzanine floor of the Hotel Statler, and the Technical Sessions will be held in the Georgian Room. At these Technical Sessions papers will be given on radiant heating methods, industrial ventilation, weather data, and fuels. Reports of Officers and standing committees will be given, and members who plan to attend should make their reservations early.

THREE NEW CHAPTERS ORGANIZED

CENTRAL OHIO CHAPTER

The Charter for the Central Ohio Chapter of the American Society of Heating and Ventilating Engineers was presented by S. H. Downs, Kalamazoo, Mich., President of the Society, at a recent meeting in the Seneca Hotel, Columbus, Ohio, which was attended by national officers of the Society and 60 members of the new Chapter. Mr. Downs installed the newly elected officers, namely: John D. Slemmons, *President;* Prof. A. I. Brown, *Vice-President;* H. R. Allonier, *Treasurer;* A. W. Williams, *Secretary;* R. B. Breneman, T. R. Walker and F. H. Schaad, *Executive Committee.*

M. F. Blankin, Philadelphia, Past President of the Society, discussed the history of the Society and its importance in the life of a community.

The principal speaker, Dr. B. M. Woods, head of Extension Division of the University of California, Berkeley, spoke on *What Next for Air Conditioning Engineers?* He gave the principal trends of progress in this field of engineering and compared the present state of the art as on a par with illumination 40 years ago.

Members were advised of the Society's new Research program to be carried on at its own Research Laboratory in Cleveland and at 12 colleges in various parts of the country. President Slemmons read messages of greetings from a great many of the other chapters and expressed appreciation of their thoughtfulness. He also announced that the Chapter plans to hold its next meeting November 20.

Preceding the Charter Meeting of the Central Ohio Chapter the Society had sponsored a two-day meeting of its technical and other special committees at the Deshler-Wallick Hotel and among those in attendance were: S. H. Downs, Kalamazoo, President; A. J. Offner, New York, Second Vice-president; L. P. Saunders, Lockport, N. Y., Treasurer; A. V. Hutchinson, New York, Secretary; C. H. Flink, New York, Technical Secretary; C. M. Ashley, Syracuse, N. Y.; L. T. Avery, Cleveland; M. F. Blankin, Philadelphia, Past President of Society; J. F. Collins, Pittsburgh, Chairman, Guide Publication Committee; Brig. Gen. W. A. Danielson, Memphis, Tenn.; Prof. James Holt, Cambridge, Mass.; Prof. L. G. Miller, East Lansing, Mich.; Capt. A. E. Stacey, Jr., U. S. N. R., New York; G. D. Winans, Detroit; Dr. B. M. Woods, Berkeley, Calif.; Comdr. T. H. Urdahl, Washington, D. C.; Prof. G. L. Tuve, Cleveland, Chairman of Committee on Research; Cyril Tasker, Cleveland, Director of Research; Dean John A. Goff and C. S. Leopold, Philadelphia; G. H. Tuttle, Detroit; W. C. Bevington, Indianapolis; H. E. Sproull, Cincinnati, Chairman Chapter Relations Committee; Prof. T. F. Rockwell, Pittsburgh.

ROCKY MOUNTAIN CHAPTER

The first meeting of the newly chartered Rocky Mountain Chapter of the Society was held at the Cosmopolitan Hotel, Denver, Colo., on October 11, with an attendance of 55.

A. J. Offner, New York, Second Vice-President of the Society, presented the charter to the Rocky Mountain Chapter, and W. A. Russell, Kansas City, Mo., congratulated the members on the formation of the Society's 33rd chapter. An interesting talk by Mr. Offner dealt with the fascinating subject of Heating and Air Conditioning Design and Construction Practices in Latin America. He described some interesting installations in Mexico, Central and South America. He also mentioned the scarcity of fuel in Brazil, and said that some factory type buildings burn surplus coffee. He explained that coffee beans must be treated with oil and they have only about half the calorific value of coal.

Among the visiting members from other chapters were D. M. Allen, President of the Kansas City Chapter, who extended congratulations to the newly formed group. Many other messages were received from Chapters all over the country congratulating the Rocky Mountain group and wishing them success.

Representatives from local professional organizations, architects, illuminating engineers, mechanical engineers, all responded and congratulated the newly formed Chapter.

Before the meeting adjourned the officers were elected and installed as follows: J. H. McCabe, *President*; G. D. Maves, *Vice-President*; William McCoy Larimer, *Treasurer*; Frank L. Adams, *Secretary*; and J. J. Johnson, John Bernzen, and D. J. McQuaid as *Board of Governors.*

MEMPHIS CHAPTER

The third chapter organization meeting of the month was held at the Peabody Hotel, Memphis, October 18, at which time President S. H. Downs, Kalamazoo, presented the official charter of the Memphis Chapter.

A talk on the functions of the Society was given by M. F. Blankin, Philadelphia, Past President of the Society, and among the other speakers were Brig. Gen. W. A. Danielson, Memphis, member of the Council; H. E. Sproull, Cincinnati, chairman of the Chapter Relations Committee; and W. A. Russell, Kansas City, nominee for Second Vice President.

The newly elected Chapter officers were installed by President Downs as follows: President, J. J. Nolan; Vice President, T. J. O'Brien; Secretary, W. E. Thorpe; and Treasurer, Carl Fischer.

Messages of greeting from many of the other Chapters were read.

Summer Weather Data and Sol-Air Temperature—Study of Data for New York City

By C. O. Mackey* and E. B. Watson,** Ithaca, N. Y.

SUMMARY—Hourly summer weather data in New York, N. Y., for the months of June, July, August, and September for the ten-year period from 1932 through 1941 have been studied for the purpose of obtaining information to be used in the estimate of cooling loads. Design temperature curves are presented in the form of sol-air temperatures. The sol-air temperature combines the effect of outdoor air temperature and solar radiation incident upon the building surface into one temperature; this temperature of the outdoor air in contact with a shaded surface will give the same contribution to the cooling load as that given by the combined air temperature and solar effects

THIS IS a discussion of a method of analysis of available summer weather data in order to obtain information of some value to engineers interested in the effect of solar heat upon cooling load and in other related problems. The intensity of the total radiation received from sun and sky on a horizontal surface is continuously recorded at several stations in the United States maintained by the U. S. Weather Bureau and also at a number of cooperating stations. Hourly readings of the temperature of the outdoor air are also recorded. The intensity of direct solar radiation received in a plane perpendicular to the sun's rays is measured at four of these stations. Monthly summaries of these data appear in the Monthly Weather Review.

The sol-air temperature seems to be the most logical combination of these readings in analyzing problems in heat transfer. As explained in an earlier paper,† the *sol-air temperature* is the temperature of the outdoor air which, in contact with the shaded surface of any building material that does not directly transmit solar radiation, would give the same rate of heat transfer and the same temperature distribution through that material as exists with the actual outdoor air temperature and solar radiation incident upon the sunlit surface.

For either steady or unsteady flow of heat, the instantaneous rate of heat entry into the outside surface of a sunlit building material, which does not directly transmit solar radiation, is:

$$\left[\frac{q}{A}\right]_L = bI + h\,(t_a - t_L) \text{ Btu/hr ft}^2,$$

where

b = absorptivity of the surface for solar radiation;
I = intensity of incident solar radiation, Btu/hr ft²;
h = film coefficient of heat transfer between outdoor air and surface of the material Btu/hr ft²F;
t_a = temperature of outdoor air, F;
t_L = temperature of surface of material, F.

Note that

$$bI + h(t_a - t_L) = h\left[\frac{bI}{h} + t_a - t_L\right]$$

Let the sol-air temperature be defined as:

$$t_s = t_a + \frac{bI}{h}$$

Then, the instantaneous rate of heat entry into the material at the outside surface may also be expressed as

$$\left[\frac{q}{A}\right]_L = h\,(t_s - t_L)$$

The sol-air temperature concept is new but extremely useful, because the effects of air temperature and solar radiation upon the rate of heat transfer and the temperature distribution through the sunlit material are combined. In other words, an increment in one degree in the modulus, $\frac{bI}{h}$, which has the dimensions of temperature, has precisely the same effect upon the temperature of the *inside* surface, and the rate of heat transfer at that surface contributing to the cooling load, as would an increment of one degree in the temperature of the outdoor air.

A more complete discussion of sol-air temperature, with numerical examples, is given in Appendix A for materials which do not directly transmit solar radiation, and in Appendix E for glass.

Hourly readings of the dry-bulb temperature of the outdoor air and the total solar and sky radiation incident upon a *horizontal* surface for each hour of each day during the months of June, July, August, and September for the ten-year period from 1932 through 1941 were obtained from data reported by the New York Meteorological Observatory located in Central Park at a north latitude of 40°46′, a west longitude of 73°58′, and at an elevation of 180 ft above sea level. Considerable atmospheric contamination reduces the intensity of solar radiation received at this station, but Dr. I. F. Hand of the U. S. Weather Bureau believes that *values representative of average large city conditions* are obtained.

Table 1 gives temperature data; the maximum temperature at each hour during June, for example, is the maximum of 300 recorded temperatures; the temperature listed as equalled or exceeded by that at only 5 per cent of the total hours would be that temperature equalled or exceeded in June, for example,

* Professor of Heat-Power Engineering, Cornell University. Member of ASHVE.
** Assistant Professor of Engineering Materials, Cornell University.

† Summer Comfort Factors as Influenced by the Thermal Properties of Building Materials, by C. O. Mackey and L. T. Wright, Jr. (ASHVE Transactions, Vol. 49, 1943, p. 148.)

For presentation at the 51st Annual Meeting of the American Society of Heating and Ventilating Engineers, Boston, Mass., January 1945.

Table 1—Outdoor Air Temperature Data—New York City

(Maximum hourly outdoor air temperature in the shade, and hourly outdoor air temperature equalled or exceeded on no more than 5 per cent of the days during a given month in the period from 1932 through 1941)

Time of Day (E.S.T.)	Temperature of the Outdoor Air in the Shade, deg F — Maximum				Equalled or Exceeded Only 5 Per Cent of the Total Hours, 1932-1941			
	June	July	August	September	June	July	August	September
1 AM	80	84	85	79	76	78	77	73
2	78	82	84	78	75	77	76	72
3	77	81	83	77	74	77	75	72
4	77	81	82	77	73	76	75	71
5	77	80	81	75	74	76	74	71
6	81	82	82	75	75	76	75	71
7	84	86	84	78	77	80	78	72
8	86	90	86	80	80	82	80	74
9	90	92	91	83	82	86	83	77
10	91	95	93	86	84	88	86	80
11	94	98	95	89	87	90	88	83
12	96	100	96	90	88	92	90	85
1 PM	97	102	98	93	90	93	91	87
2	98	104	100	96	91	94	91	87
3	99	105	99	96	90	94	91	88
4	100	106	96	92	89	94	91	86
5	97	105	97	90	89	93	90	85
6	94	103	96	87	87	90	88	82
7	92	94	94	86	84	88	85	79
8	88	93	93	84	82	85	83	77
9	86	92	91	83	80	83	81	76
10	85	88	89	82	79	82	80	75
11	83	85	87	80	78	81	78	74
12	81	84	86	79	76	79	77	73
24-hour average of above	88.0	92.1	90.3	84.0	81.7	84.8	82.6	77.9

[a]Tables presented here are taken from a thesis by Mr. Watson for the degree of Master of Science in Engineering at Cornell University.

Table 2—Intensity of Total Solar and Sky Radiation on a Horizontal Surface—New York City

(Maximum hourly intensity, and hourly intensity equalled or exceeded on no more than 5 per cent of the days during a given month in the period from 1932 through 1941; all times are Eastern Standard)

Time of Day	Intensity of Total Solar and Sky Radiation on Horizontal Plane, Btu/hr ft² — Maximum				Equalled or Exceeded Only 5 Per Cent of the Total Hours, 1932-1941			
	June	July	August	September	June	July	August	September
6 AM	45	51	28	..	30	28	15	..
7	127	127	84	52	91	80	59	31
8	206	160	146	154	153	144	126	87
9	279	216	211	183	205	196	180	151
10	318	268	261	224	249	236	210	197
11	347	295	288	252	287	260	244	224
12	362	305	301	270	302	278	266	241
1 PM	360	300	305	279	287	278	264	239
2	343	289	292	268	260	267	241	221
3	326	258	256	226	280	225	216	186
4	258	215	206	183	215	189	171	150
5	187	166	142	118	163	137	123	91
6	112	108	84	66	85	82	65	37
7	38	44	31	..	35	31	19	..

Table 3—Maximum Sol-Air Temperature for Horizontal Surface in New York City

(Maximum values for 10-year period, 1932-1941)

Time of Day (E.S.T.)	Sol-Air Temperature, deg F — June			July			August			September		
(Solar Absorptivity)	(1.0)	(0.7)	(0.4)	(1.0)	(0.7)	(0.4)	(1.0)	(0.7)	(0.4)	(1.0)	(0.7)	(0.4)
1 AM	80	80	80	84	84	84	85	85	85	79	79	79
2	78	78	78	82	82	82	84	84	84	78	78	78
3	77	77	77	81	81	81	83	83	83	77	77	77
4	77	77	77	80	80	80	82	82	82	77	77	77
5	77	77	77	82	82	82	81	81	81	75	75	75
6	86	85	85	86	85	83	86	85	84	75	75	75
7	102	95	90	104	98	92	98	94	90	89	85	81
8	125	111	96	118	108	100	113	103	95	107	95	86
9	141	123	106	139	124	108	130	117	105	119	106	95
10	149	127	111	148	132	116	145	128	111	134	118	103
11	155	135	115	157	139	122	150	132	116	145	126	108
12	162	140	118	162	143	125	160	141	121	150	131	112
1 PM	163	145	122	170	146	126	161	141	121	151	132	114
2	164	142	122	163	145	127	161	141	121	150	137	115
3	155	137	120	169	150	131	153	135	118	141	125	111
4	143	129	117	144	133	121	140	127	113	128	117	106
5	131	121	110	131	123	116	125	115	106	111	104	98
6	115	108	102	113	110	107	109	104	99	95	93	90
7	100	98	95	100	98	96	94	96	95	86	86	86
8	88	88	88	93	93	93	93	93	93	84	84	84
9	86	86	86	92	92	92	91	91	91	83	83	83
10	85	85	85	88	88	88	89	89	89	82	82	82
11	83	83	83	85	85	85	87	87	87	80	80	80
12	81	81	81	84	84	84	86	86	86	79	79	79
24-hour average of above	112.6	104.5	96.7	114.8	107.7	100.9	111.9	105.0	98.2	103.1	96.8	90.6

by 15 of the 300 readings for that hour.

Table 2 gives solar radiation data; the maximum intensity of total solar and sky radiation received on a horizontal surface is listed for each hour during each month of the ten-year period. Also the hourly intensity equalled or exceeded on no more than 5 per cent of the days at a given hour during each month of the ten-year period is given.

Table 3 gives the maximum sol-air temperature for the months of June, July, August, and September for a horizontal surface with three solar absorptivities, 1.0, 0.7, and 0.4. All sol-air temperatures are based upon Equation 1 of this report (Appendix A). Careful observers may note what appears to be a discrepancy in Tables 1, 2, and 3. For example, *if* the maximum air temperature and the maximum solar radiation had occurred *simultaneously* at 12 noon in June, the maximum sol-air temperature for the horizontal surface with solar absorptivity, b, of 1.0 would have been $\left[96 + \frac{362}{4}\right]$ or 186.5 F; actually, the maximum sol-air temperature for this hour and month was observed to be only 162 F. The reason for this is the observed fact that *the maximum air temperatures and the maximum solar radiation do not, in general, occur simultaneously.* It is not correct, therefore, to combine maximum values of the two effects, and the need for some concept like the sol-air temperature becomes apparent. Another apparent discrepancy may be found if one assumes that the difference between the sol-air temperatures for $b = 1$ and $b = 0.7$ should be the same as the difference for $b = 0.7$ and $b = 0.4$; this need not be the case, however, for the temperature of the air becomes more important when the solar absorptivity decreases. In other words, the maximum sol-air temperature for $b = 1$ might occur on the day when the solar radiation is a maximum, while for $b = 0.4$ the sol-air temperature may be a maximum on the day when the temperature of the air is a maximum. This latter effect is small, and for most practical purposes the difference

between the sol-air temperature for any solar absorptivity and the sol-air temperature for zero absorptivity (air temperature in the shade) may be assumed to be directly proportional to that solar absorptivity.

Since the 24-hour average of the sol-air temperature is greater for July than for any other month, the sol-air temperature at each hour in July which is equalled or exceeded at that hour only 16 times in 310 observations in July (ten-year period) has been chosen as the design sol-air temperature of the outdoor air. These temperatures are plotted in Fig. 1 for a horizontal surface, and the result is a design curve for New York City which is recommended for use in calculations of heat transfer through horizontal surfaces in that locality. Similar curves must be found for other localities before any general design curves may be drawn.

The design curves include the air temperature in the shade (solar absorptivity of zero) and three curves of sol-air temperatures for solar absorptivities of 1.0, 0.7, and 0.4. Although data on solar absorptivity are not very complete, it is recommended that a solar absorptivity of 1.0 be used for very dark colors, 0.7 for medium colors, and 0.4 for very light colors; the air temperature curve should be used for all surfaces completely shaded from direct solar and diffuse sky radiation.

Vertical Surfaces

It would be desirable to have the sol-air temperature of the outdoor air for vertical surfaces of various orientations in order that the flow of heat through such surfaces might be found. The Weather Bureau has made very few observations of the intensity of solar radiation received on vertical surfaces. If it were not for the fact that part of the total observed radiation received upon the horizontal surface is diffuse or sky radiation, it would be relatively simple to calculate the intensity on a vertical surface from the observations on the horizontal surface. (For direct, or beamed, solar radiation, the ratio of the intensity on a vertical surface to the intensity on a horizontal surface may be found as explained in Appendix B.)

As solar radiation passes through the earth's atmosphere, part is turned aside from the direct beam and scattered in practically all directions with no appreciable change in wave length. A considerable portion of the total radiation received on a horizontal surface is in the form of this diffuse radiation from the sky. On cloudy days, all radiation is diffuse, while on clear days the ratio of diffuse to direct radiation varies with the solar altitude and with the amount of dust, water vapor, and other material in the atmosphere. This ratio is large for low solar altitudes, cloudy days, and large amounts of smoke and dust in the atmosphere. On clear days, in cities near the times of sunrise and sunset, the diffuse radiation generally amounts to more than one-half of the total received on a horizontal surface, while on high mountains the diffuse radiation is almost negligible except with very low sun.

From a large number of measurements of diffuse radiation, Dr. I. F. Hand gives the following table in Monthly Weather Review, 1937, page 437, for the ratio of direct solar radiation on a horizontal surface to diffuse sky radiation on that surface during cloudless days in Washington, D. C.:

Solar altitude, H....	60°	30°	11.3°
Ratio of direct to diffuse radiation, summer	5.2	3.1	1.5
Ratio of direct to diffuse radiation, winter	8.1	5.0	1.7

The summer results are shown plotted in Fig. 2, in the form of the ratio of direct to diffuse radiation received on a horizontal surface as a function of solar altitude.

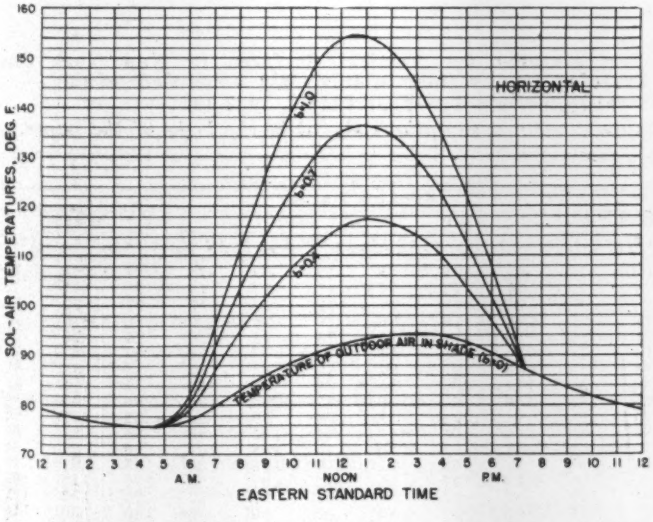


Fig. 1—Design temperatures for horizontal surface in New York, N. Y.

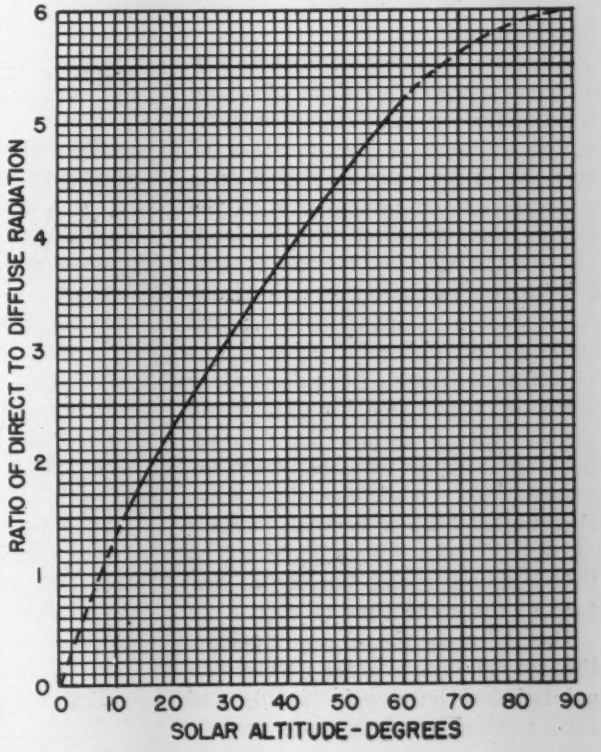


Fig. 2—Ratio of direct to diffuse radiation on horizontal surfaces; summer data; Eastern states.

Table 4—Sol-Air Temperature for Horizontal Surface in New York City Equalled or Exceeded at Any Hour Only 5 Per Cent of the Total Hours in a Ten-Year Period, 1932-1941

Time of Day (E.S.T.)	Sol-Air Temperature, deg F											
	June			July			August			September		
(Solar Absorptivity)	(1.0)	(0.7)	(0.4)	(1.0)	(0.7)	(0.4)	(1.0)	(0.7)	(0.4)	(1.0)	(0.7)	(0.4)
1 AM	76	76	76	78	78	78	77	77	77	73	73	73
2	75	75	75	77	77	77	76	76	76	72	72	72
3	74	74	74	77	77	77	75	75	75	72	72	72
4	73	73	73	76	76	76	75	75	75	71	71	71
5	74	74	74	76	76	76	74	74	74	71	71	71
6	79	78	76	81	79	78	78	77	77	71	71	71
7	93	88	83	96	92	87	89	85	81	78	77	75
8	108	99	91	110	102	93	106	98	90	91	84	82
9	123	111	99	127	114	101	122	111	97	106	97	88
10	137	121	105	137	122	108	131	117	103	121	108	94
11	143	127	109	148	130	112	141	124	108	131	116	103
12	149	131	112	155	135	116	148	129	113	136	121	106
1 PM	148	130	116	154	136	118	150	132	114	141	124	108
2	150	132	113	152	134	116	146	130	113	136	121	106
3	141	125	110	144	129	113	140	125	110	128	115	102
4	132	119	106	136	123	110	129	118	106	118	107	97
5	121	111	101	121	112	104	116	108	100	101	95	91
6	104	99	94	106	101	96	101	97	91	87	85	83
7	92	89	87	93	91	90	88	87	86	79	79	79
8	82	82	82	85	85	85	83	83	83	77	77	77
9	80	80	80	83	83	83	81	81	81	76	76	76
10	79	79	79	82	82	82	80	80	80	75	75	75
11	78	78	78	81	81	81	78	78	78	74	74	74
12	76	76	76	79	79	79	77	77	77	73	73	73
24-hour average of above	103.6	97.0	90.3	106.4	99.8	93.2	103.0	96.4	90.2	94.1	88.9	84.2

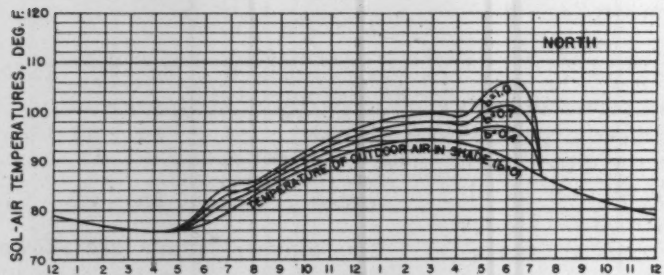


Fig. 3—Design temperatures for surface facing North in New York, N. Y.

The resulting curve is typical for eastern states.

The point of greatest uncertainty in the extension of data obtained from radiation incident upon horizontal surfaces is the question of how the diffuse sky radiation on a vertical surface compares with the diffuse sky radiation on a horizontal surface. What fraction of this diffuse sky radiation on a horizontal surface is incident upon vertical surfaces of different orientations at different times of the day? Only more complete radiation data would answer this question. In this report, for simplicity, it has been assumed that the diffuse sky radiation incident on a vertical surface of any orientation is one-half of that incident upon a horizontal surface at the same time of day.

Based upon these assumptions, the sol-air temperatures were calculated for the month of July and for vertical surfaces of various orientations and are shown in Table 5. These are the sol-air temperatures that were equalled or exceeded on no more than 5 per cent of the days during that month in the ten-year period from 1932 to 1941. These values are not as reliable as those for the horizontal surface, because they are based upon the assumed breakdown of total radiation into direct and diffuse and a further assumed ratio of diffuse radiation on the vertical surfaces to diffuse radiation on a horizontal surface. However, the curve of Fig. 2 is believed to be fairly reliable, and the effect of the assumption concerning the diffuse radiation incident upon the vertical surface is relatively unimportant in the final result as is shown in Appendix C.

The recommended design curves for sol-air temperature for New

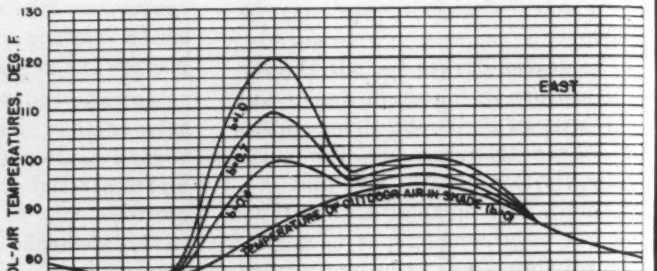


Fig. 4—Design temperatures for surface facing East in New York, N. Y.

Table 5—Sol-Air Temperatures for Vertical Surfaces in New York City Equalled or Exceeded at Any Hour in July Only 5 Per Cent of the Total Hours in a Ten-Year Period, 1932-1941

(Calculated values based upon assumptions stated in the body of the paper.)

Time of Day (E.S.T.)	Sol-Air Temperature, deg F											
	Surface Facing											
	North			East			South			West		
(Solar Absorptivity)	(1.0)	(0.7)	(0.4)	(1.0)	(0.7)	(0.4)	(1.0)	(0.7)	(0.4)	(1.0)	(0.7)	(0.4)
1 AM	78	78	78	78	78	78	78	78	78	78	78	78
2	77	77	77	77	77	77	77	77	77	77	77	77
3	77	77	77	77	77	77	77	77	77	77	77	77
4	76	76	76	76	76	76	76	76	76	76	76	76
5	76	76	76	76	76	76	76	76	76	76	76	76
6	80	79	77	89	85	81	77	77	76	77	77	76
7	85	83	82	106	98	91	82	82	81	82	82	81
8	85	84	83	114	105	95	86	85	83	85	84	83
9	90	89	88	120	109	99	97	94	90	90	89	88
10	92	91	90	114	106	98	104	99	94	92	91	90
11	94	93	92	106	101	97	111	105	98	94	93	92
12	97	95	93	97	95	94	115	108	101	98	96	94
1 PM	98	96	95	98	96	95	117	110	103	108	104	99
2	99	97	96	99	97	96	112	107	101	126	116	107
3	99	97	96	99	97	96	102	99	97	136	123	111
4	99	97	96	99	97	96	99	98	96	145	130	114
5	103	100	97	97	96	95	97	96	95	140	126	112
6	106	101	96	93	92	91	93	92	91	134	120	107
7	102	98	94	90	89	89	90	89	89	115	107	99
8	85	85	85	85	85	85	85	85	85	85	85	85
9	83	83	83	83	83	83	83	83	83	83	83	83
10	82	82	82	82	82	82	82	82	82	82	82	82
11	81	81	81	81	81	81	81	81	81	81	81	81
12	79	79	79	79	79	79	79	79	79	79	79	79
24-hour average of above	88.5	87.3	86.2	92.3	89.9	87.8	90.7	89.0	87.1	96.5	93.0	89.5

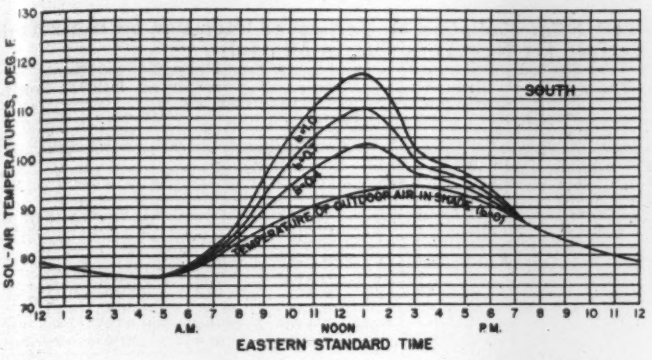


Fig. 5—Design temperatures for surface facing South in New York, N. Y.

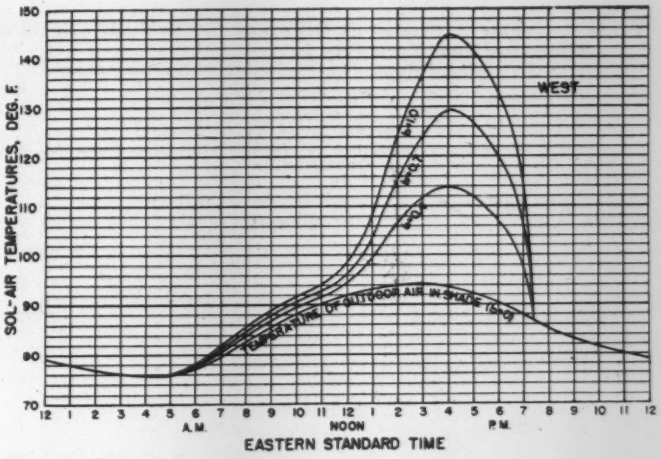


Fig. 6—Design temperatures for surface facing West in New York, N. Y.

York City are shown for vertical surfaces with different values of solar absorptivity facing north (Fig. 3), facing east (Fig. 4), facing south (Fig. 5), and facing west (Fig. 6).

Equations for Sol-Air Temperature

For the few who may be interested, equations for the recommended design sol-air temperatures for New York City are presented in the form of trigonometric series. In all of these equations, θ represents the time in hours after noon (E.S.T.).

Design temperature of outdoor air in shade:

$$t_a = 84.8 + 9.0 \cos (15\theta - 42) + 1.1 \cos (30\theta - 28) + 0.7 \cos (45\theta - 228) + 0.3 \cos (60\theta - 225)$$

Design sol-air temperature of outdoor air for horizontal surfaces:

Solar absorptivity of 1.0,

$$t_e = 106.4 + 39.7 \cos (15\theta - 15) + 11.5 \cos (30\theta - 17) + 2.0 \cos (45\theta - 210) + 1.4 \cos (60\theta - 217)$$

Design sol-air temperature of outdoor air for vertical surfaces facing *North*

Solar absorptivity of 1.0,

$$t_e = 88.5 + 12.9 \cos (15\theta - 44) + 1.8 \cos (30\theta - 165) + 2.6 \cos (45\theta - 253) + 2.1 \cos (60\theta - 12)$$

Design sol-air temperature for vertical surfaces facing *East*

Solar absorptivity of 1.0,

$$t_e = 92.3 + 15.5 \cos (15\theta - 356) + 6.9 \cos (30\theta - 262) + 8.3 \cos 45\theta - 209) + 2.6 \cos (60\theta - 154)$$

Design sol-air temperature for vertical surfaces facing *South*

Solar absorptivity of 1.0,

$$t_e = 90.7 + 17.6 \cos (15\theta - 22) + 6.3 \cos (30\theta - 5) + 2.3 \cos (45\theta - 284) + 0.9 \cos (60\theta - 5)$$

Design sol-air temperature for vertical surfaces facing *West*

Solar absorptivity of 1.0,

$$t_e = 96.5 + 28.1 \cos (15\theta - 54) + 12.6 \cos (30\theta - 125) + 8.0 \cos (45\theta - 203) + 2.2 \cos (60\theta - 281)$$

Sol-Air Temperature for Glass

The sol-air temperatures given in this paper are to be used only for estimating the rate of heat flow from the indoor surfaces of materials which do not directly transmit incident solar radiation. Part of the total radiation incident upon glass is directly transmitted, part is reflected, and part is absorbed. If the sol-air temperature concept is to be used for predicting the heat flow through glass, this temperature must be increased to allow for the direct transmission of some of the incident radiation. Exact application requires a knowledge of the transmissivity and absorptivity of glass as a function of the angle of incidence of the sun's rays. This point is discussed further in Appendix E. The simplest procedure in obtaining design information concerning the contribution to the cooling load due to heat transfer through glass would probably be to multiply the values of total radiation received on a horizontal surface, as given in Table 2, by an appropriate factor at each hour; this factor would include the combined effects of glass orientation and the effect of angle of incidence upon absorptivity and transmissivity.

Appendix
Methods and Equations

A. Sol-Air Temperature

For the surface of a material which does not directly transmit solar radiation, the sol-air temperature may be found from observed values of the air temperature and the total solar and sky radiation incident upon that surface as follows:

$$t_e = t_a + \frac{bI}{h} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where

t_e = the sol-air temperature, F;
t_a = the dry-bulb temperature of the outdoor air in the shade, F;
I = the intensity of total solar and sky radiation incident upon the surface, Btu/hr ft²;
b = the absorptivity of the surface for the incident total radiation;
h = the film coefficient of heat transfer between surface and air, Btu/hr ft² F. (Actually, this coefficient depends upon wind velocity, but it was assumed to be a constant and equal to 4 in this study.)

Example: Observed dry-bulb temperature of outdoor air in the shade is $t_a = 78$ F; observed total radiation incident upon *horizontal* surface is $I = 200$ Btu/hr ft². For a surface absorptivity of 0.7, the sol-air temperature for the *horizontal* surface is:

$$t_e = 78 + \frac{0.7\ (200)}{4} = 113 \text{ F}$$

In other words, air at a dry-bulb temperature of 113 F in contact with the completely *shaded* surface would give the same temperature distribution and rate of heat flow through the building material as exists with an air temperature of 78 F, incident total radiation of 200 Btu/hr ft², and a surface absorptivity of 0.7. This concept permits combining the effects of air temperature and solar radiation.

B. Trigonometric Relations

The intensity of *direct* solar radiation on a horizontal surface is substantially equal to the product of the intensity of direct solar radiation received on a plane perpendicular to the sun's rays and the cosine of the angle between the sun's rays and the normal to the horizontal, or

$$I_H = K_H I_o \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where

I_H = the intensity of *direct* solar radiation received on a horizontal surface, Btu/hr ft²;
I_o = the intensity of *direct* solar radiation received on a plane per-

Table A—Solar Altitudes at Different Times for New York City in Mid-July

Time (E.S.T.)	Solar Altitude North Latitude of 40°46′, West Longitude of 73°58′ and Solar Declination of 21°36′
4:36 AM	0 (sunrise)
5	4° 2′
6	14°40′
7	25°47′
8	37° 7′
9	48°21′
10	58°56′
11	67°29′
12 noon	70°49′
1 PM	66°31′
2	57°33′
3	46°50′
4	35°33′
5	24°14′
6	13°10′
7	2°38′
7:16	0 (sunset)

Table B—Ratio of Direct Solar Radiation on Vertical to Radiation on Horizontal Surface for New York City in Mid-July

Time (E.S.T.)	Ratio: Direct Solar Radiation on Vertical Surface to Direct Solar Radiation on Horizontal Surface — Vertical Surface Facing							
	N	NE	E	SE	S	SW	W	NW
5 AM	6.044	13.335	12.814	4.787				
6	1.059	3.346	3.673	1.848				
7	0.254	1.633	2.055	1.273				
8		0.894	1.321	0.973	0.056			
9		0.460	0.864	0.762	0.213			
10		0.167	0.526	0.580	0.295			
11			0.243	0.481	0.335	0.065		
12 noon				0.238	0.349	0.259	0.018	
1 PM				0.003	0.333	0.433	0.280	
2					0.287	0.604	0.568	0.265
3					0.196	0.788	0.918	0.510
4					0.028	1.009	1.399	0.970
5						1.396	2.198	1.783
6						1.987	4.083	3.787
7						6.889	19.900	20.645

pendicular to the sun's rays, Btu/hr ft².

$$K_H = \cos (90 - H) \quad \ldots\ldots (3)$$

or

$$K_H = \sin D \sin L + \cos D \cos L \cos (360 - \theta) \quad \ldots\ldots (4)$$

where

H = the solar altitude, degrees;

D = the declination of the sun, degrees;

L = the latitude of the surface, degrees;

θ = the hour angle of the sun measured west from the zenith, degrees.

The intensity of *direct* solar radiation on a vertical surface is:

$$I_v = K_v I_o \quad \ldots\ldots (5)$$

where

I_v = the intensity of *direct* solar radiation received on a vertical surface, Btu/hr ft²;

$$K_v = \cos H \cos B \quad \ldots\ldots (6)$$

and

$$B = A_v - 90 - A_s \quad \ldots\ldots (7)$$

where

A_v = the azimuth of the trace of the vertical surface, measured west from south, degrees;

A_s = the azimuth of the sun measured west from south, degrees. (If cos B is zero or negative, the vertical surface is receiving no *direct* solar radiation.)

The azimuth of the sun may be found from the following relation:

$$\sin (A_s - 180) = \frac{\cos D \sin (360 - \theta)}{\cos H} \quad (8)$$

If the *direct* solar radiation received on a horizontal surface is known, the *direct* solar radiation that is then incident upon a vertical surface of any orientation may be computed.

Tables A and B used in the calculations are offered here because they may be of some interest in similar calculations. Table A gives the solar altitudes at different times for a north latitude of 40°46′ and a west longitude of 73°58′ (New York) and a solar declination of 21°36′ (mid-July).

In all of this study, the small difference between mean solar time and apparent solar time was ignored. Since New York is east of the 75th meridian, the mean sun is 1°2′ ahead of the position indicated by Eastern Standard Time. Although the position of the *mean* sun may be corrected to the position of the *true* sun through the equation of time, this correction was ignored.

Table B gives the ratio of direct solar radiation on a vertical surface to direct solar radiation on a horizontal surface for a north latitude of 40°46′, a west longitude of 73°58′ and a solar declination of 21°36′ (New York in mid-July).

The assumption with the least data to authorize it, and fortunately, the one with the least effect upon the result, is that the intensity of diffuse sky radiation on a vertical surface, regardless of orientation and sun position, is one-half of the intensity of diffuse sky radiation on a horizontal surface at the same time. The steps in finding the diffuse radiation incident upon a vertical surface corresponding to the observed total radiation on a horizontal surface equalled or exceeded on no more than 5 per cent of the days during the month of July (Table 2) are shown in Table C. The solar altitude at each hour is calculated on the assumption of a solar declination of 21°36′ (mid-July).

Some data for the observed intensities of diffuse sky radiation on vertical surfaces facing south, east, and west were plotted by Houghten, Shore, Olson, and Gunst in the ASHVE Transactions, Vol. 46, 1940, p. 95. From these data, a suggested design curve for diffuse sky radiation on vertical surfaces was obtained. (see Fig C-1). This curve is compared with the data obtained in Table C. The diffuse sky radiation on a vertical surface depends upon the orientation of that surface with respect to the sun as well as the solar altitude and is not a constant fraction of the diffuse radiation on a horizontal surface at the same time. However, it is believed that the diffuse radiation assumed in preparing the sol-air temperature curves for vertical surfaces in this report is within about 10 Btu/hr ft² of the actual, and the equivalent temperatures for vertical surfaces are not over 3 F in error, even for the case where the solar absorptivity is 1.0.

It should be noted that observed values of the total radiation incident upon a horizontal surface must always be broken down into direct and diffuse radiation before any attempt is made to *estimate* the total radiation incident upon a vertical surface, and the trigonometric calculation will apply only to the *direct* radiation. For example, assume the total solar radiation received on a horizontal surface at 6 p.m. in New York in mid-July is 82 Btu/hr ft,² and that it is required to find the total radiation incident at that time upon a vertical wall facing west. The ratio of *direct*

Table C—Determination of Diffuse Radiation on Vertical Surface from Total Sky and Sky Radiation on a Horizontal Surface

Time (E.S.T.)	Total Solar and Sky Radiation on a Horizontal Surface, Btu/hr ft² (From Table 2)	Solar Altitude	Ratio of Direct to Diffuse Radiation on Horizontal Surface (From Fig. 2)	Diffuse Radiation Incident Upon Horizontal Surface Btu/hr ft²	Diffuse Radiation Incident Upon Vertical Surface (Assumed)
6 AM	28	14°40′	1.80	10.0	5.0
7	80	25°47′	2.75	21.4	10.7
8	144	37° 7′	3.60	31.4	15.7
9	196	48°21′	4.40	36.3	18.2
10	236	58°56′	5.13	38.5	19.3
11	260	67°29′	5.50	40.0	20.0
12	278	70°49′	5.61	42.0	21.0
1 PM	278	66°31′	5.48	43.0	21.5
2	267	57°33′	5.03	44.3	22.2
3	225	46°50′	4.28	42.7	21.4
4	189	35°33′	3.50	42.0	21.0
5	137	24°14′	2.65	37.5	18.8
6	82	13°10′	1.67	30.7	15.4
7	31	2°38′	0.35	23.0	11.5

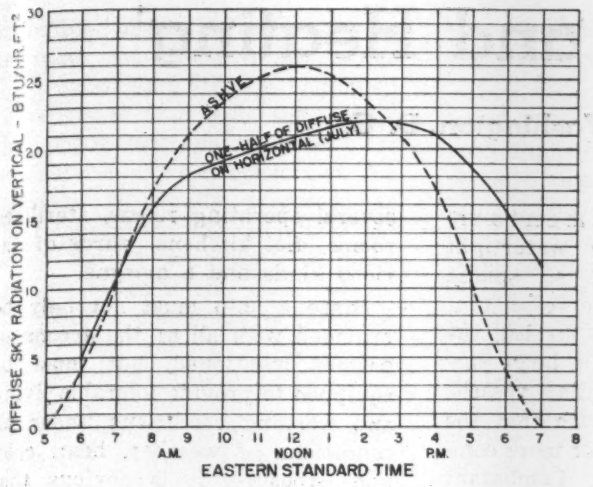


Fig. C1

solar radiation on this vertical wall to the *direct* solar radiation on a horizontal surface at this time is 4.083. If one were to assume that this was also the ratio of *total* radiation, one might conclude that the total radiation incident upon the west wall would be 4.083 (82) or 323 Btu/hr ft². This is incorrect, however, because about 31 of the 82 Btu/hr ft² incident upon the horizontal is diffuse sky radiation; hence, the total radiation incident upon the west wall at this time is more nearly [4.083 (51) + 0.5 (31)] or 224 Btu/hr ft².

D. Sol-Air Temperature for Vertical Surfaces

The method used in obtaining the sol-air temperature for a vertical surface is illustrated by the following sample calculation:

At 9 a.m. (E.S.T.), the observed temperature of the outdoor air in the shade at the New York Meteorological Observatory is $t_a = 78$ F, and the observed total solar and sky radiation incident upon the horizontal surface is $I = 200$ Btu/hr ft². The declination of the sun at this time is $D = 21°36'$. It is desired to find the sol-air temperature at this time for a vertical surface with an absorptivity of $b = 1.0$, facing *east*.

From Equation 4,

$$K_H = (\sin 21°36')(\sin 40°46') + (\cos 21°36')(\cos 40°46')(\cos 43°58') = 0.7472$$

Since sin $H = 0.7472$, the solar altitude at this time is $H = 48°21'$.

From Fig. 2, the ratio of direct solar radiation to diffuse sky radiation for this solar altitude is 4.4. The diffuse sky radiation on the horizontal surface is 200/5.4 or 37 Btu/hr ft², while the direct solar radiation on the horizontal surface is 163 Btu/hr ft².

The azimuth of the sun at this time, A_s, may be found from Equation 8:

$$\sin (A_s - 180) = \frac{(\cos 21°36')(\sin 43°58')}{\cos 48°21'} = 0.9712, \text{ or}$$

$$A_s = 283°47'$$

For a vertical surface facing *east*, the azimuth of the trace of the surface is $A_v = 360°$, and from Equation 7,

$$B = 360° - 90° - 283°47' = -13°47'$$

From Equation 6,

$$K_v = (\cos 48°21')(\cos -13°47') = 0.6455$$

The intensity of *direct* solar radiation on the vertical surface facing east is:

$$I_v = \frac{0.6455}{0.7472}(163) = 140.8 \text{ Btu/hr ft}^2$$

The intensity of diffuse sky radiation on the vertical surface is assumed to be one-half of that on the horizontal surface or 18.5 Btu/hr ft².

The *total* solar and sky radiation incident on the vertical surface facing east is:

$$I = 140.8 + 18.5 = 159.3 \text{ Btu/hr ft}^2$$

For a solar absorptivity of $b = 1.0$, the sol-air temperature at this time for the vertical surface facing east is, from Equation 1,

$$t_e = 78 + \frac{159.3}{4} = 118 \text{ F}$$

E. Sol-Air Temperature for Glass

Assume that the fraction of incident total radiation which is transmitted directly through glass, the transmissivity, is designated by t; the fraction absorbed, absorptivity, by b; the fraction reflected, reflectivity, by r.

Then,

$$t + b + r = 1$$

For the steady flow of heat through glass (no heat storage), it may be shown that the contribution to the cooling load per square foot of glass due to heat directly transmitted and heat conducted through the glass is:

$$\frac{q}{A} = \left(\frac{q}{A}\right)_t + \left(\frac{q}{A}\right)_c = tI + U\left[(t_a - t_i) + \frac{bI}{h}\right] \quad \ldots (9)$$

where

$\frac{q}{A}$ = the contribution to the cooling load, Btu/hr ft²,

I = the total solar and sky radiation incident upon the outdoor surface of the glass, Btu/hr ft²,

U = the overall coefficient of heat transfer of the glass, Btu/hr ft² F,

h = the film coefficient of heat transfer at the outside surface of the glass, Btu/hr ft² F,

t_a = the temperature of the outdoor air, F,

t_i = the temperature of the indoor air, F.

Note that

$$\frac{q}{A} = U\left[\left(t_a + \frac{bI}{h} + \frac{tI}{U}\right) - t_i\right] \quad \ldots (10a)$$

$$= U(t_e - t_i) \quad \ldots (10b)$$

The sol-air temperature for glass is:

$$t_e = t_a + I\left(\frac{b}{h} + \frac{t}{U}\right) \quad \ldots (11)$$

Unfortunately, the absorptivity, b, and the transmissivity, t, are not constant but vary with the angle of incidence of the sun's rays; this variation would have to be known for an exact application of this principle.

As an illustration of the use of Equation 11, consider the following case:

Assume the intensity of the incident solar and sky radiation is 300 Btu/hr ft² on a surface at normal incidence to the sun's rays; assume $t_a = 90$ F, $h = 4$ Btu/hr ft² F, and $U = 1.13$ Btu/hr ft² F. For normal incidence of the sun's rays on ordinary window glass, $b = 0.04$ and $t = 0.88$. Then, the sol-air temperature for the glass in this case with the sun's rays at normal incidence is:

$$t_e = 90 + 300\left(\frac{0.04}{4} + \frac{0.88}{1.13}\right) = 327 \text{ F}$$

The rate of heat transfer to the inside of the enclosure with $t_i = 80$ F, is, for this case,

$$\frac{q}{A} = 1.13(327 - 80) = 279 \text{ Btu/hr ft}^2$$

For engineering purposes, since the second term on the right side of Equation 9 is small in comparison with the first, the contribution to the cooling load due to heat transfer through glass is, approximately,

$$\frac{q}{A} = tI \quad \ldots (12)$$

In the foregoing example, the use of this approximation would give a result of 264 Btu/hr ft² instead of the correct result of 279 Btu/hr ft².

SORMANE JOINS CONCO

Announcement has been made of the appointment of Walter Sormane as general sales manager, Conco Engineering Works, Mendota, Ill. Formerly Mr. Sormane was sales manager of Schwitzer-Cummins Co., Indianapolis, where for 12 years he was identified with the development of small stokers. Mr. Sormane was recently re-elected as vice-president of the Stoker Manufacturers Association, and he is a member of the Stoker Industry Advisory Committee of the WPB.

Ship Ventilation and Heating†

By John W. Markert*, Washington, D. C.

A SHIP is not a piece of steel so shaped that it can carry a certain amount of ventilation and heating equipment. Neither is it constructed for the purpose of having an elaborate launching party or trial trip. Actually a ship is designed to do a specific job. If it is a cargo ship it may be compared to a general delivery truck, or if it is designed for a specific trade it serves one purpose just as a baker's pie wagon does. An LST vessel may be compared to the Holland or Lincoln Tunnel, while an aircraft carrier actually is a floating air field.

Ship Proportions

If a vessel is to be designed for a specific job, the first step is to determine how large it must be. Its displacement can be obtained by any combination of the three variables; length, breadth, and draft of which length is the most expensive to increase. Obviously, the draft is limited to the depth of water to be encountered while in service, the LST being a notable example of design for a limited draft. A large vessel designed to go between the East and West Coasts of the United States would be limited in beam or breadth by the width of the Panama Canal. The length of a vessel would be limited by the length of the pier to be used or in some cases by the bends in the rivers to be navigated. After the principal dimensions of the vessel have been established, it is necessary to determine the resistance of the vessel by testing a scale model of it in a model testing basin. The test data obtained enable the designer to accurately determine the horsepower required to propel the vessel.

The design of the vessel above the waterline is determined by the volume required for all purposes. This volume within the main hull is divided into numerous watertight compartments. On a merchant ship compartments are formed by providing watertight transverse bulkheads, so spaced along the length of the vessel that if one compartment is flooded, the vessel will still float. On large passenger ships and similar vessels, the spacing may be such that the vessel will float if two or more compartments are flooded. Combatant vessels are virtually *honeycombed* with watertight subdivisions—vertical, horizontal, and athwartships—in order to make them less vulnerable.

The structure above the main hull is made sufficiently large to house the personnel and equipment required to operate the vessel. There is always a tendency to skimp on the deck heights of the superstructure because the greater they (the deck heights) are the higher will be the ship's center of gravity, and consequently the lower will be its stability. The practice of adding more mechanical and electrical equipment to modern ships has tended to raise the minimum deck height. While a height of 7 ft to 7 ft 6 in. was used during the last war, 8 ft 6 in. is a more common height today.

Facilities Required

A ship must contain practically everything required for living plus many types of factory facilities. In a passenger vessel, besides dry cargo and refrigerated cargo holds, engine rooms, sleeping spaces, and commissary spaces, there are barber shops, beauty parlors, children's playrooms, swimming pools, gymnasiums, bars, theaters, shopping centers, telephone exchanges, and even dog kennels. On naval auxiliary vessels there are elaborate machine shops, optical shops, carpenter shops, bending slabs, dope rooms, sewing rooms, foundries and electrical shops.

All seagoing vessels have some sort of hospital accommodations, which may vary from simple one room spaces, equipped with a few berths and a medicine chest, to large accommodations including several operating rooms, sterilizer rooms, diet kitchens, wards of various kinds and a morgue.

Since a ship must not only be provided with all of the accommodations mentioned, but must be equipped to provide tolerable living and working conditions under all conditions of weather, heat, cold, and exposure, it is obvious that the design problem is quite complicated.

History of Ship Ventilation

Naval architects and marine engineers are frequently criticized for the methods now used for ventilating and heating ships. Often, too, members of the shipbuilding profession are prone to forget past developments. Very few radical changes have occurred without some rebound, an example being the introduction of welding without which present shipbuilding records could not have been achieved, but with which some serious problems have been added.

A study of the progress in ship ventilation and heating in the 20th century has been made by the author and proved to be extremely interesting. A summary[1] has already been published.

Ventilation and Heating Aboard Ships

The following is a brief description of the methods commonly used today for ventilating and heating ships. While, in general, the same methods are used for both, certain specific differences exist in the treatment of Naval and Merchant vessels. However, these differences are of a confidential nature and therefore cannot be discussed at this time.

Ventilation in most cases is provided to maintain acceptable standards of air purity and/or *comfort*. The word *comfort* is actually a misnomer in many cases because

†Presented at a meeting of the New York Chapter.

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[1]Fifty Years of Progress in Ship Ventilation and Heating, by John W. Markert (ASHVE Journal Section, *Heating, Piping & Air Conditioning*, October, 1944, p. 603.)

in reality ventilation only provides tolerable conditions in a specific space according to the accepted conventional standards set up for that particular type of space.

Where *comfort* is concerned, the standard is usually expressed as the temperature rise permitted between the air supplied to a space and the space itself. The outside temperature commonly is taken as 88 F. The ambient temperature rise permitted will vary from 5 F for passenger accommodations to 30 F for a space containing large heat producing sources, such as found in engine and boiler rooms, galleys, and laundries. The usual practice for the latter type space is to *spot cool* working stations by projection of the supply air toward the occupants at high velocities (2,000 to 3,500 fpm) from outlets about 6 ft from the occupants. It is obvious that under no circumstances can ventilation reduce the temperature of the space below that of the outside air.

The ventilation of spaces such as group berthing spaces, halls, and mess rooms is governed usually by the number of occupants, 20 to 50 cfm being allowed for each one, depending on the quality of ventilation sought and the length of occupancy. Approximately 30 cfm per occupant is almost universally used for troop spaces. In most cases where the deck-head is an exposed surface, temperature rise calculations usually require more air than occupancy or air change estimates would indicate.

The method of determining ventilation requirements by providing a predetermined number of air changes is frequently used for quick estimates. It must be definitely understood that such a method is not accurate where ventilation is to be provided for *comfort*. The ventilation of such spaces as toilets, showers, washrooms, lamp rooms, gasoline pump rooms, paint rooms, and holds is governed by the air change required.

Most ship spaces which require heat are served by means of the hot blast system. Where spaces are not provided with mechanical supply ventilation, or where ventilation is not considered essential during the heating cycle, direct radiation is used in the form of convectors, radiators, finned pipe heating elements, and unit heaters.

The relation of ventilation to heating in a hot blast system is such that the designer must compromise between the *cooling* and heating loads of respective spaces. While it is simpler to take care of these loads independently by providing a separate means for heating each space, it is neither necessary nor economical in many instances to do so. A compromise can often be obtained without seriously impairing the efficiency of either. By providing a heater for a group of spaces having proportional heating and *cooling* loads, a large number of separate heaters may be eliminated. This arrangement is known as the *zone system* and is the one most commonly used on cargo ships and crew's quarters on passenger vessels. On troop ships the berthing and messing spaces are frequently large enough to justify one or two separate hot blast systems for each space. In a more compact arrangement the preheater and reheater are placed back to back ahead of the fan. The preheater thermostat protects the heaters against freezing, thus eliminating the necessity for steam distributing tube preheaters.

In the past many staterooms on passenger vessels were fitted with an arrangement known as the *dual duct* system. This system permitted the passenger to regulate room temperature by operating manually a mixing damper which varied the proportion of hot and cold air delivered. As the dual duct system is rather clumsy and complicated, a split system consisting of a tempered ventilation system and convectors for heat is considered more practical. The recent trend for passenger accommodations appears to be a unit system in which the air is preheated by a central heater and reheated by automatically controlled boosters for each individual space. Basically, this system is the same as the zone system, except that each zone represents a room, and the reheater thermostat is controlled by a single bulb located in the room. The air in a split system is usually tempered to a value between 70 and 80 F. A similar arrangement is used to prevent drafts in galleys, pantries, laundries, and similar spaces which require ventilation all year 'round but which generate large quantities of heat. In such cases the air is usually tempered to a value between 50 to 60 F.

Insulation and Ventilation

With few exceptions it is more difficult to supply ventilation requirements than heating. It is, therefore, strange that so much consideration is given to heating and so little to *cooling* when the insulation treatment of a ship is selected. Insulation is usually provided for engine rooms, galleys, and similar spaces to prevent the transfer of heat from these spaces. In the past, however, the insulation of living spaces has been considered with respect to heating rather than cooling. Within the last few years with the introduction of air conditioning principles it has been realized that the air change method of determining ventilation loads is, to say the least, unscientific. It is not uncommon for a living space to require fewer than six air changes an hour for heating but over fifteen air changes an hour in order to limit the temperature rise to 10 F. For this reason, more and more attention is being given to methods for improving insulation applications.

Ship Insulation

Most ships are built of steel, a material having a conductivity so high that it can be ignored in estimating overall heat transfer coefficients. Because of the high conductivity, steel angles, channels, and tees (used to stiffen bulkheads and decks) act the same as fins of convectors and blast coils. As these members are frequently irregular in shape and size, they add considerably to the complications of the insulating job.

Experiments of both the Navy and the Maritime Commission have emphasized the importance of covering all steel stiffening members as well as the structure itself in order to stop heat leaks through the structure. One inch of insulation on a bulkhead plating, beams and stiffeners is better than two inches of insulation on the bulkhead plating itself. This is particularly important on fighting ships where

weight is important. On merchant ships the insulation is frequently covered, to improve appearance, by applying a non-metallic, fireproof material over the face of beams and stiffeners. This sheathing must have good insulating properties unless thermal resistance must be sacrificed for strength. Obviously, the sheathing also forms a valuable air space between the insulation on the exposed structure and the sheathing itself.

The subject of insulation, therefore, is becoming a far more important part of the ventilation engineer's work than ever before, and extensive applications of air conditioning in the future will emphasize its importance. It must be confessed that the perfect insulation has not been found; that is one that has high insulating efficiency, is easy to install, lasts forever, and costs nothing to apply.

Influence of Labor

The industry must thank labor for some of the progress made in the ventilation and heating of ships. No American crew will sail on a ship which does not have bracket fans installed in living and messing spaces, galleys, and pantries. It is interesting to note that the installation of these fans was one of the first changes made in revising the basic British Liberty ship design for American operation. Frankly, considering the prewar merchant standards of mechanical ventilation, it is surprising that the unions could be convinced to furnish men for many of the earlier emergency vessels which had only the most meager natural ventilation equipment. Naturally, the crews complained about the inadequate ventilation on these vessels. Nevertheless, they stood by and did their job even when they had to live in uninsulated rooms with walls of steel on vessels anchored for days in some harbor in the tropics during a calm. Mushroom or torpedo ventilators had to be closed at night because they were not light-excluding, and while blackout louvers were provided for airports very little ventilation could be obtained with only a light breeze blowing. Also, while many of the earlier types of louvers were light-excluding (if properly made and fitted squarely into the airport frame) they were constructed so that very little air passed through even with a stiff wind blowing.

No one could imagine any possible degree of *comfort* or do a good job under the above circumstances.

Comparison of Liberty and Victory Ships

The following comparison of the Liberty and Victory Cargo Ships will show the progress that has been made in improving conditions.

The Victory Ship may be considered a refinement of the Liberty Ship, particularly with respect to the ventilation and heating. The refinements may be classified as (a) corrections based on service experience; (b) modifications due to change in propulsion equipment and generator capacity; and (c) development of new ventilating equipment.

The original Liberty Ship was not equipped with mechanical ventilation. Cowls were provided for supplying air to the engine and boiler spaces, while the exhaust was obtained by skylights, forced draft fan, and outer stack casing. Cowls were also used for ventilating holds, stores spaces, shaft alley, and steering gear spaces. Mushrooms and torpedo ventilators were provided for exhausting the quarters, messrooms, and pantries. Goosenecks were fitted for exhausting toilet and shower spaces. A skylight was fitted for carrying off the heat of coal burning ranges and steam kettles in the galley.

The first improvement was the installation of bracket fans in the living spaces and after this, mechanical supply ventilation was provided for reducing the ambient temperature in the vicinity of the air cooled refrigeration compressor serving the ship's refrigerated stores space. The steward's and certain critical stores spaces were then provided with mechanical supply ventilation. The *blacking out* made necessary by the war was first achieved by closing the engine room and galley skylights and the airports. The resulting discomfort was slightly improved by installing blackout louvers in these openings. Further improvement was provided in the galley by a mechanical exhaust propeller fan, the most common being a "pent house" arrangement. Somewhat later after numerous makeshift arrangements proved ineffective, a special ventilator of the ridge type was substituted for the engine room skylight. This ventilator was both light and weathertight, and was provided with a damper for controlling the air flow.

The Liberty Ship machinery space exhaust ventilator was developed simultaneously with the basic design of the Victory Ships, in which this improvement was also adopted. The Victory Ship design includes mechanical supply ventilation for the combined engine and boiler room. Two 28,000 cfm axial flow fans are used for this purpose. The supply air is distributed by a system of duct work and high velocity directional terminals for blasting the working areas and watch stations. A 12,000 cfm axial flow fan is also provided for exhausting hot spots in the after portion of the machinery space. During the development of the design a special study was made to determine the best location of doors for providing easy access to the engine room axial flow fan motors. A large portion of the supply air is exhausted by means of the forced draft fans, the remainder being exhausted through the special ventilator which replaces the conventional skylight.

Natural ventilation of holds in Victory Ships is obtained by using cowls for supply and goosenecks or special patented terminals for exhaust. Each cowl is seated on a series of rollers to facilitate trimming. The steering gear room is served by a cowl for supply and a patented ventilator for exhaust.

Service reports from Liberty vessels indicated that more positive ventilation should be provided for the quarters, messrooms, and toilet spaces. Each of the living spaces on the Victory Ships, therefore, is fitted with one or two mechanical porthole blackout ventilators, depending on the size of the space. The Victory Ships are the first ships to be fitted with these special ventilators, which can be used to supply or exhaust air from the space concerned, both day and night. The ventilator can also be operated like a bracket fan in

which case some air is drawn in through the air port and the remainder recirculated. The device handles in excess of 300 cfm as a supply or exhaust fan, and in excess of 750 cfm as a bracket fan. New Liberty Ships, as well as many now in service, are being fitted out with identical or similar mechanical porthole blackout ventilators. Considering the fact that the average living space would normally be provided with only about 150 cfm, if served by the conventional duct system, the operating personnel have welcomed this new development.

A mechanical exhaust system is provided for the toilets, showers, radio room, gyro room, and butcher shop of the Victory Ships. A No. 10 standard centrifugal fan is used for this purpose. A No. 40 standard centrifugal fan is used to exhaust the galley and pantries. The stewards' stores, CO_2 room, laundry, and certain additional stowage spaces are served by supply systems fitted with standard No. 10 centrifugal fans.

The heating systems provided for the Victory Ships are quite different from those used in the Liberty Ships. The latter are fitted with a heating system based on a 15 F outside temperature and a 65 F inside temperature. The system operates on 15 psi steam with cast iron wall radiators in the heated spaces. The heating system of the Victory Ships, on the other hand, conforms to standard Maritime Commission practice. The outside design temperature is 0 F, while in most cases 70 F is the inside design temperature. The wheelhouse and several miscellaneous working spaces are heated to somewhat lower temperatures. The system operates on steam at 35 psi, which is also used for the various domestic services.

All spaces, except for the steering gear room, which is heated by a unit heater having a non-ferrous heating element, are heated by means of standard Maritime Commission convectors.

Victory Troopships

The ventilation and heating system of the Victory Troopships is consistent with both Naval and Commission standard practice.

A large part of the naval architect's work has been to design the systems and to select equipment in such a way as to reduce the range of sizes to a minimum. All lists of terminals, goosenecks, covers, grilles, registers, diffusers, volume controllers, fans, heaters, convectors, etc., were studied after preliminary working plans had been completed. A survey indicated that odd sizes could be weeded out, leaving an amazingly small number of required sizes. As an example, only five sizes of convectors were used on the Victory Troopships, the total number being about fifty. Such standardization will easily repay the effort expended because it simplifies greatly the procurement, manufacturing, installation, and replacement of equipment.

Equipment and Practice

In a recent article in Heating, Piping & Air Conditioning, William Goodman said, with respect to air conditioning controls, "In many cases, the most satisfactory installations are those with relatively simple control systems without complications." This thought aptly expresses what is considered good marine practice—simple in design and foolproof in operation.

Centrifugal and Axial Flow Fans

The relative merits of axial flow and centrifugal fans have been and will be discussed with great interest for some time. Each type has its best applications and, to say the least, the axial flow fan cannot be said to be the answer to *all* marine requirements. The inaccessibility of direct connected motors on the smaller axial flow fans, particularly d.c. types, is a disadvantage. Fan compactness for straight runs of duct, on the other hand, is of considerable importance. From a viewpoint of standardization, the axial flow fan cannot be excelled. Aside from the type of current and motor enclosure, there are no other variables and considering the many mistakes made in specifying motor rotations, discharges and mountings on centrifugal fans, this fact becomes very important.

The centrifugal fan still has its place where explosive, corrosive, grease laden, or hot vapors are to be handled. Furthermore, where right angle bends occur in a system, a centrifugal fan may be better suited to the installation. Also, the critical relationship between the downstream air direction and the decibel rating of axial flow fans leaves something to be desired. Exceptional efficiencies are important only in large fans where a motor of less horsepower may be used because of improved efficiency. It must be understood, however, that except for engine room fans, there are relatively few fans on a merchant ship which fall into this category.

The future success of the axial flow fan will to a great degree depend on the sincerity of the manufacturer in realizing its limitations and upon the manufacturer's efforts to educate the user in the proper use of this equipment.

Heaters and Convectors

In the matter of heaters and convectors there are two schools of thought regarding the basic construction and installation. The Navy prefers to install the heaters with tubes in horizontal and headers in vertical position. Both the supply and drain connections are on the same side of the heater. Casings of Navy coils are watertight. The Maritime Commission practice requires that preheaters be installed with tubes vertical to facilitate drainage, with supply and return connections on opposite sides of all heaters in order to avoid congestion of piping. Both Navy and Commission practice permit between 0.5 in. to 0.75 in. total air pressure drop for both preheater and reheater. The face velocity under these circumstances is usually less than 1200 fpm.

Both the Navy and Maritime Commission have standardized on a sloping top, wall hung type of convector. The physical sizes of the Commission's convectors of equivalent output are the same as the Navy's. The Navy has 10 standard sizes ranging from 1500 Btu/hr to 20,000 Btu/hr. The Commission has seven sizes ranging from 3500 Btu/hr to 20,000 Btu/hr. The Commission has found that finned pipe heating elements are very suitable in certain spaces which do not have wall space for convectors

and which have a large uninsulated exposure such as found in large toilet and shower spaces.

Filters

Filters seem to have been first used in breweries about 1900. All Commission filters are specified on the basis of Bureau of Standards tests and recent reports indicate that there is considerable room for improvement. It is interesting to know that both grease and air filters are now required to pass the same test. While this may seem to be ridiculous, it should be noted, however, that recent tests indicate that the specifying of grease filters to pass air filter tests may not be so far afield as it first sounds.

Conclusion

In conclusion, I wish to point out that the shipbuilding industry has contributed greatly to the progress of ventilation and heating.

"In 1890 the Navy found that little reliable data were available pertaining to the performance of fans and the laws governing air flow in ducts. The Navy, therefore, started to find out for itself and the first results were presented before the Society of Naval Architects and Marine Engineers in 1895 by Admiral D. W. Taylor, U.S.N. This report included a complete study of the friction and static pressure losses in pipes, elbows, transitions, etc. It also introduced a new method of testing fans which is very similar to that in use today. In addition, this report introduced backward curve wheels for centrifugal fans in an effort to prove that the commercial fans then available were not suitable for Navy use. Needless to say, this paper was met by considerable opposition. One statement by the opposition worth while quoting reads as follows: From D. W. Taylor's paper (discussion on)—

"I have estimated that the entire amount of fans required for Marine Service in the course of a year would only constitute about 3 per cent of the business of one of our large fan manufacturers, and the request of the Navy Department seems to be about the only urgent one for a fan of greater efficiency. Furthermore, the demands of the Navy Department for an absolutely convertible fan is of great hindrance to the production of a fan of increased efficiency."

Time alone has proven the value of Admiral Taylor's report to the industry, as well as the Navy.

The Navy's present interest in axial flow fans will undoubtedly stimulate fan development. Similarly the progress which is being made to develop more efficient air and grease filters will also benefit the air conditioning industry as a whole.

RESEARCH FUND GROWING

Prof. G. L. Tuve, Chairman of the Committee on Research and Samuel R. Lewis, Chairman of the Research Finance Committee, express their gratification for the response of the industry to the invitation to contribute to the general research fund and various earmarked projects.

An unexpected, but nevertheless acceptable, contribution has been tendered by the Illinois Chapter.

ILLINOIS CHAPTER

American Society of Heating and Ventilating Engineers

SECRETARY'S OFFICE
ROOM 1605, 6 N. MICHIGAN AVE.
CHICAGO 2, ILLINOIS PHONE: STATE 6916

October 25, 1944

Mr. Cyril Tasker
Director of Research
ASHVE Research Laboratory
10700 Euclid Ave.
Cleveland 6, Ohio

Dear Mr. Tasker:

You will recall that, following your talk on the Society's research program at our October meeting, it was unanimously moved that the Illinois Chapter give your work its enthusiastic endorsement and practical support. It is our pleasure now to forward you herewith a contribution from our Chapter's funds.

We well know that this vitally important work must be financed through the voluntary support of companies and individuals in this industry, in addition to that part of each member's dues which is allocated to research. The amount a Chapter like ours can give from a limited treasury is a small part of your total needs but it is a token of our interest as a group and our desire to be a participant in one of the most constructive and valuable programs ever undertaken by the Society.

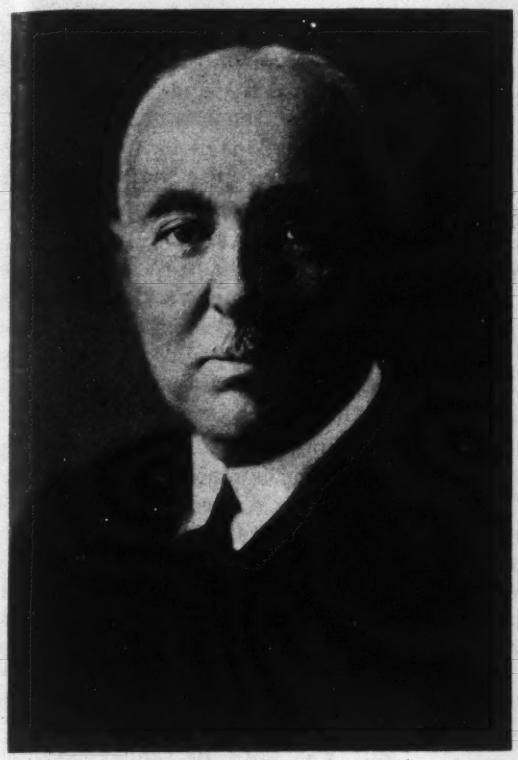
Illinois is proud of the vision and practical aims of your program. It is confident of results which will greatly advance our industry and profession. You have our thanks for your complete and inspiring presentation of our research plans and our best wishes for full success in enlisting the aid of the entire heating, ventilating and air conditioning industry.

Very truly yours,

A. O. May
President
Illinois Chapter

AOM:MM
Enc.

NOMINEES FOR 1945 OFFICERS

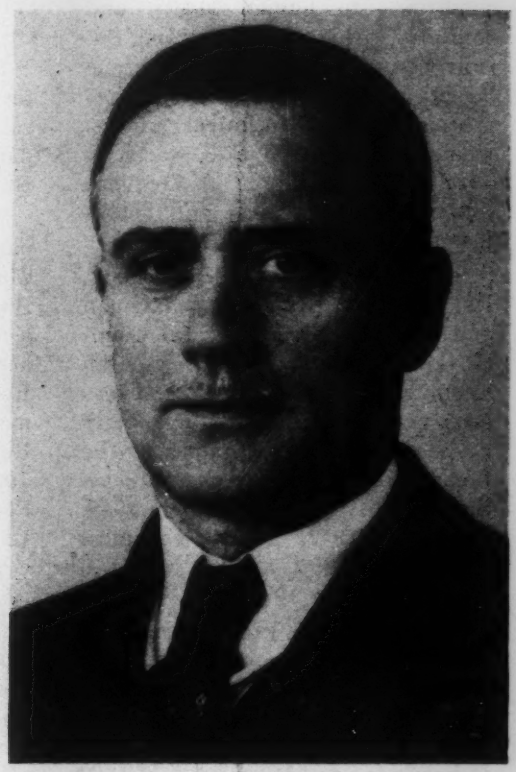


C.-E. A. Winslow
New Haven, Conn.
President

A · S · H · V · E ·

Alfred J. Offner
New York, N. Y.
First Vice-President

W. A. Russell
Kansas City, Mo.
Second Vice-President



L. P. Saunders
Lockport, N. Y.
Treasurer

1945 NOMINEES FOR OFFICERS

For President—C.-E. A. Winslow, New Haven, Conn., was born in Boston, February 4, 1877. He was graduated from the Massachusetts Institute of Technology, receiving his S.B. in 1898 and his S.M. in 1899, and in 1918 he was awarded an honorary degree of Doctor of Public Health (Dr.P.H.) from New York University.

Dr. Winslow taught in the Department of Biology and Public Health at Massachusetts Institute of Technology from 1898-1910, at which time he became Associate Professor of Biology, College of the City of New York, which he held until 1915. From 1915 up to the present he has been Professor of Public Health at Yale University.

He served as Chairman of the New York Commission on Ventilation from 1913-1923. In 1932 he became Director of the John B. Pierce Laboratory of Hygiene, New Haven, Conn.

Dr. Winslow has conducted researches and published numerous papers on relation of atmospheric conditions to human health and comfort, including ventilation. Besides being the author of numerous books on these subjects, he has presented many technical papers, which appear in the Society's Transactions, and is a frequent contributor to medical and health journals and other publications.

Since joining the Society in 1932, Dr. Winslow served as chairman and as a member of several Council Committees and many Research Technical Advisory Committees each year. For the past five years he has served as a member of the Committee on Research, serving on its Executive Committee in 1938, 1940 and 1942, as its Technical Adviser in 1939, and as its Vice-Chairman from 1940-42.

Dr. Winslow is vice-chairman of the Council, chairman of the Meetings Committee, and chairman of the F. Paul Anderson Award Committee. He is also a member of the Committee on Research, and is serving on the Technical Advisory Committees on Air Sterilization and Odor Control, and on Physiological Reactions.

Dr. Winslow is also a member of many other associations, the American Bacteriologists, American Public Health Association, National Institute of Health, Academy of Arts and Sciences, Society of Experimental Biology and Medicine, New England Water Works Association and American Public Health Council, etc.

* * *

For First Vice-President—Alfred J. Offner, Consulting Engineer, New York, N. Y., was born June 24, 1888. He was educated in New York and holds degrees in B.S. and M.E. from Cooper Union, where he taught advanced physics for five years.

He spent six years as draftsman and engineer with Konrad Meier, Consulting Engineer, and five years as engineer with Henry C. Meyer, Jr., Consulting Engineer. In 1919 he became senior member of the firm of Offner and McKnight, Consulting Engineers. In 1930 Mr. Offner opened his own office.

He was the consulting engineer for numerous government and private buildings located in various parts of the United States, also in Europe, South America and Asia.

Mr. Offner has taken an active part in the affairs of the New York Chapter, having served on the Board of Governors in 1928-29, and as its President in 1930. He was a member of the New York City Building Code Committee, and a member of the Building Laws and Regulations Code Committee in 1929. In 1930-31 he served on the Professional Engineering Licensing Law Committee.

Mr. Offner has been a member of the Society's Council since 1935, and served as Treasurer of the Society from 1935 to 1938. He has been Chairman of the Admissions and Advancement Committee, and Chairman of the Regional Meetings Committee in 1938 and '39. He was a member of the Guide Publication Committee for three years, being Chairman in 1942. He also served as Chairman of the Finance Committee in 1939 and '40, and as a member of the Executive Committee of the Council in 1941 and '42.

Mr. Offer is the chairman of the Executive Committee of the Council.

Mr. Offner has presented papers before the Society and has written numerous articles on the subject of heating and ventilation, and wrote the original chapter on hot water heating in the Society's Guide.

Besides being a member of the Society he is also a member of the New York Association of Consulting Engineers, serving as its president in 1936 and 1937.

* * *

For Second Vice-President—William A. Russell, Kansas City, Mo., was born in Chicago on December 27, 1886. After his graduation from the University High School he attended the University of Michigan.

He spent two years building factory buildings as construction superintendent of the Central Manufacturing District, Chicago, and four years as boiler salesman with the Spencer Heater Co., Chicago Branch. For the next four years he was with the Mine and Smelter Supply Co., Denver, Colo., as a special sales representative on products of U. S. Radiator Corp. Mr. Russell then became Kansas City branch manager of the U. S. Radiator Corp., where he served for 20 years. In 1937 he went to Detroit, in charge of the Capitolaire Division. Since 1938 he has been with Hoffman Specialty Co. and is now Southwestern zone manager with headquarters in Kansas City.

Mr. Russell joined the Society in 1921 and has served on the Council, has been chairman of the Membership and Speakers Bureau Committees, has served on the Nominating Committee and many special committees. He is a member of the 1944 Committee on Constitution and By-Laws.

He has actively participated in

chapter work and served the Kansas City Chapter as Treasurer in 1921 and as President in 1932.

* * *

For Treasurer — Laurence P. Saunders, Chief Engineer of Research Engineering, Harrison Radiator Div., General Motors Corp., Lockport, N. Y., was born on June 24, 1891, at Stroud Green, London, England, and received his elementary training from private tutors in both England and the United States. He later attended Westbourne Grove College in England.

In 1906 he entered the employ of Messrs. Legros and Knowles, London, automobile manufacturers, and from 1910-1914 he was connected with various U. S. and Canadian factories.

From 1914 to 1919 he served in the British Navy as an engineer on diesel engine craft. Following World War No. 1, Mr. Saunders joined General Motors Research Corp., Dayton, Ohio, and in 1920 he became associated with the Harrison Radiator Division of the Corporation, where he developed modern methods of car radiator testing in the laboratory.

He joined the Society in 1933 and served as treasurer, 2nd vice-president, 1st vice-president, and president of the Western New York Chapter from 1936-39. He served on several Chapter Committees, Membership, Nominating and Speakers, and as a member of several Research Technical Advisory Committees of the Society.

He was elected a member of the Council of the Society in 1941 for a three-year term, and is a member of the current Committee on Research serving a three-year term, as well as a member of the Special Committee on Chapter Relations. He is also Chairman of the Standards Committee, and is a member of the Research Technical Advisory Committees on Corrosion, the Flow of Fluids Through Pipes and Fittings, Heat Transfer of Finned Tubes, and Air Distribution and Air Friction.

Mr. Saunders has written extensively on evaporative cooling, and radiator development and car cooling for SAE Journal; and on research and automotive progress for other automotive publications.

He holds membership in the Aero Club of Buffalo, American Society of Naval Engineers (civilian member), American Society of Refrigerating Engineers, Detroit Engineering Society, Institute of Automobile Engineers, Professional Engineers Society, Rochester Engineering Society of Automotive Engineers, serving as a member of their National Nominating Committee and their Committee on Heat Exchangers for Aircraft A-7. He also served as a member of the National Advisory Committee for Aeronautics, as a member of the sub-committee on Heat Exchangers for Aircraft. Mr. Saunders is a member of the Cooperative Research Council serving on the sub-committees on Coolant Systems, as Chairman of sub-committee on High Pressure Radiator Design, and as a member of the New Coolant Liquids Committee.

Mr. Saunders is a member of the Rotary and Tuscarora Clubs of Lockport, and is chairman of the Boy Scout Troop Committee.

Mr. Saunders is ex-officio member of the Finance Committee.

N. T. SELLMAN IN NEW POST

N. T. Sellman, Scarsdale, N. Y., who has served with Consolidated Edison Systems Companies for 31 years, has been elected Vice President of the Westchester Lighting Co. and the Yonkers Electric Light and Power Co.

Mr. Sellman is an Assistant Vice President of Consolidated Edison Co., New York, in charge of Electric and Gas Sales.

Born in Sweden in 1890, Mr. Sellman was graduated from Stevens Institute of Technology in New Jersey with the degree of mechanical engineer in 1913, becoming a test engineer for the Consolidated Gas Co. In 1916 he entered the army, serving first on the Mexican border and then in World War 1 as a lieutenant in the 30th Engineers, in France until 1919.

Returning to the Consolidated Gas Co. in 1921, Mr. Sellman joined the American Gas Association, of which he later became assistant secretary-manager. He returned to Consolidated in 1925 as engineer of utilization, became assistant secretary in 1928 and director of sales and utilization in 1929.

Since the merger of the gas and electric companies into the Consolidated Edison Co. in 1936, he has been assistant vice president in charge of sales. Prior to the merger he was a director of several of the system's gas companies.

The new Westchester Lighting executive was the first person to receive the Charles A. Munroe award of the American Gas Association, considered the highest award in the gas industry. He was active in the development of the automatic gas refrigerator and also of the certified-performance gas range. He is a member of the American Society of Heating and Ventilating Engineers, the Society of Gas Lighting and the American Society of Military Engineers. At the World's Fair he was treasurer of gas exhibits.

RICHMOND ACQUIRES PIERCE EQUIPMENT

John J. Hall, vice-president and general sales manager of the Richmond Radiator Co., New York, N. Y., has announced the purchase from the Pierce Butler Radiator Corp., Syracuse, N. Y., of that company's equipment for the manufacture of its principal lines of boilers and radiators. The equipment will be installed in one of the Richmond plants and will be in production before the end of the year.

AGA LABORATORY GUESTS

When the offices and laboratories of the American Gas Association were destroyed October 20 during the disastrous fire and explosion in the adjoining plant of the East Ohio Gas Co., the ASHVE officers promptly offered all possible assistance to Director R. M. Conner through Professor G. L. Tuve, chairman of the Committee on Research.

A telegram to the president of the AGA said:

"Confirming verbal message to R. M. Conner, we gladly place office and laboratory space in the Society's Research Laboratory, 10700 Enclid Avenue, Cleveland, at the disposal of your staff, pending arrangements to re-establish your laboratory."

Mr. Conner was pleased to accept the Society's offer and a part of his staff is now occupying heretofore unused space on the first mezzanine of our laboratory.

Members on Active Duty[1]

U. S. Army

ADAIR, J. S., Sgt., 20th T.S.S.
ARONSON, H. H., Pvt., M.P.E.G.

BACHMANN, A. J., S/Sgt., 588th Bomb Sqdn.
BACHOFER, H. A., Jr., T/Sgt., 983rd Bomb Sqdn.
BADGETT, W. H., Lt.-Col., Infantry.
BARNES, H. S., Capt., 99th C. A. (aa)
BERNARD, E. L., Capt., Hq. 3rd Army, Engrs. Sec.
BERZELIUS, C. E., Lt.-Col., T.C.
BICHOWSKY, F. R., O.R.S., Air Support Command.
BOYD, R. L., Jr., 2nd Lt., Hq. Sec. Serv., C.U. 1976.
BROWN, H. J., 1st Lt., Ordnance.
BRUNDAGE, F. W., 1st Lt., 423rd C.A.
BRYAN, W. L., Lt., Hygiene Unit.
BURNS, F. G. Major, Infantry.

CAMPBELL, A. Q., Jr., Capt., F.A.
CAMPBELL, G. W., Major, Air Corps.
CANNON, V. K., Q.M.C.
CARLOCK, M. F., Capt., C.E.
CASKEY, L. H., Jr., 1st Lt., Co. F., 38th Engrs.
CHAPIN, H. G., 1st Lt., Air Corps.
CHASE, R. E., Jr., Pfc., 417th Ordnance (Avn.)
CHEESEMAN, E. W., Major, Personnel Officer, Hq. 1004 Communication.
CLARK, A. C., Capt., F.A.
CLARK, J. R., Sgt., 24th A.D.G., Supply Sqdn.
CLEMENS, J. D., Capt., Air Corps.
CLOW, S. A., 1st Lt., Signal Corps.
COLBY, J. H., Major.
COST, G. W., A/C, Air Corps.
COX, V. G., Major, C.A.
CRAWFORD, A. C., Capt., Q.M.C.
CROLEY, J. G., Capt., C.A.
CROPPER, R. O., Capt., Q.M.C.

DABBS, J. T., 1st Lt., C.A.
DANIELSON, W. A., Brig.-Gen., U.S.A.
DAVIS, M. M., Pvt., Air Corps.
DEAN, David, Pvt., 30th ERTC.
DELAUREAL, W. D., Capt.
DIAMOND, D. D., S/Sgt., 801st S.T. Bn.
DICK, H. S., Pvt., Co. A., 361st Engrs.
DICKSON, D. R., 1st Lt., Air Corps.
DICKSON, R. W., Jr., Major, Air Corps.
DRUM, L. J., Jr., Capt., C.E.
DYER, W. S., S/Sgt.

ESCHENBACH, S. P., Capt., 62nd C.A. (aa)

FARLEY, W. S., Capt., 104th Q.M. Regt.
FELDSTEIN, Harold, Major, Ordnance.
FERDERBER, M. B., Capt., M. C.
FITZGERALD, W. E., Capt., 99th Infantry Div.
FLARSHEIM, C. A., 1st Lt., A.A.F. Trng. Aids Div.
FORDERBRUGGEN, K. J., Lt.-Col. 255th AAA Bn.
FOSTER, J. G., Major, Air Corps.
FRANKLIN, S. H., Jr., Major, Ordnance
FREEMAN, A. W., 2nd Lt. Air Corps.
FRIEDLINE, J. M., Capt., C.E.

GAULT, G. W., Capt. C.E.
GEBEL, K. M., Cpl., Air Corps.
GOLDMANN, PHILIPP, Pvt., Co. A, 203rd Bn.
GOLDSMITH, Elliot, T/5.
GONZALEZ, J. L., Pilot, Air Corps.
GRABMAN, H. B., 1st Lt., 95th Engrs. Regt.
GREEN, E. W., Pvt., 87th Bn.

HAMILTON, J. B., 1st Lt., C.E.
HAWES, H. D., Lt., Instructor, A.A. School.
HENDRICKSON, W. B., S/Sgt., Air Corps School.
HERBERT, J. S., 1st Lt., Co. A., 385th Engr. Bn.
HERBERT, R. M., Lt., Air Corps.
HILL, Edward, Jr., Capt., F.A.
HINNANT, C. H., Jr., Capt., C.E.
HOLMES, R. E., 1st Lt., C.E.
HOOVER, W. L., 1st Lt., C.E.
HUBBUCH, N. J., 2nd Lt., Air Corps.
HUGHES, Samuel, Cpl., 59th Bn., Co. B.
HUNT, MacDonald, Capt., C.E.
HUST, C. E., Capt., Ordnance.
HUTCHINSON, B. L., Jr., 2nd Lt., Air Corps.

IBISON, J. L., Capt., Post Engr.
INMAN, C. M., 1st Lt., Air Corps.

JAKOBY, A. C., Pfc., Signal Corps.
JONES, H. S., 1st Lt., 17th Air Depot Group.
JONES, J. T., 2nd Lt., E.R.C.

KELLOGG, W. T., Capt., Air Corps.
KELLY, Olin A., A/C, Air Corps.
KILLOREN, D. E., 1st Lt., Hq. Co., 15th Infantry.
KLUCKHUHN, F. H., A/C, A.A.F.T.S.
KOENIG, A. C., T/Sgt., 113th Engr. Cbt. Bn.
KOTZEBUE, R. W., 1st Lt., C. E.
KROEKER, J. Donald, Capt., C.E.
KUMMER, C. J., 1st Lt., F.A.
KURTZ, R. W., Capt., Ordnance.

LANGAN, James, Pfc., C.I.T.
LARSON, C. P., Sgt., Hq. and Students Det.
LASETER, F. L., 1st Lt., Co. FE.
LENONE, J. M., Lt.-Col., C.E.
LEUPOLD, G. L., Capt., Signal Corps.
LEWIS, H. F., Capt., C.A.
LIFTON, David, Lt., Air Corps.
LIGHT, J. C., Capt., Ordnance
LINDSAY, G. W., Jr., Pvt., Co. S, 1st Regt.
LLOYD, E. H., Capt., Office, Chief of Engrs.
LONG, W. E., Capt., Signal Corps.

MACEACHIN, G. C., Major, Engrs. Aviation Bn.
MACGREGOR, C. M., Major, Ordnance.
MACMILLAN, A. R., Lt.-Col., Air Corps.
MALIN, B. S., Capt., Ordnance.
MARINO, F. A., T/Sgt. (Overseas).
MARSHALL, T. A., 1st Lt., C.E.
MARSTON, A. D., Lt.-Col., C.E.
MCCAIN, H. King, Capt., Q.M.C.
MCCLUNG, T. H., Capt., F.A.
MCDERMOTT, J. P., Capt., C.E.
MCGOWN, R. H., Jr., Pfc., 7th T.S.S.
MCKAY, A. W., Capt., Ordnance.
MEATES, R. F., Sgt., 482 Q.M.C.
MOORE, H. W., 1st Lt., Ordnance.
MORAWECK, A. H., Jr., 1st Lt., CRTC.
MORTON, H. S., Lt.-Col., Ordnance.

NEAL, J. P., Capt., Ordnance.
NELSON, A. W., Major, C.E.
NEVIN, J. F., Capt., Eastern Command.
NORRINGTON, W. L., 1st Lt., Ordnance.

ORGELMAN, G. H., Btry. A, 140 AAA.
OTTS, J. G., 1st Lt., Ordnance.

PARKER, R. A., 1st Lt., 749th M.P. Det.
PAWKETT, L. S., Capt., Air Corps.
PEISER, M. B., 1st Lt., Air Corps.
PELLMOUNTER, T. V., 2nd Lt., 55th Ordnance.
PETERSON, J. R., Pfc., Co. B, 1525 Serv. Unit.
PLOSKEY, E. J., Sgt., 40th Ordnance Co.
PHILLIPS, R. H., 1st Lt., Infantry.
PHILLIPS, W. L., Major, Air Corps.
PLEUTHNER, R. L., 2nd Lt., Air Corps.
PRAWL, F. E., Capt., Ordnance.
PREBENSEN, H. J., Major, Ordnance.
PRICE, C. F., Lt., Q.M.C.

REIF, A. F., Col., 74th Infantry.
RHEAULT, W. E., Capt., C.E.
RHINE, G. R., Major, Ordnance.
RICHARDS, G. H., Lt., C.E.
RIESECK, W. L., 2nd Lt., C.E. (Reserve).
ROBERTS, H. P., T/Sgt., H. & S. Co., 1307 Engr. G. S. Reg't.
ROSSITER, I. J., Capt., A.C.
ROTHMAN, S. C., Capt., Sn. C., Occupational Hygiene Div.
RUEMMELE, A. M., 1st Lt., Ordnance Section, PRGD.

SACHS, Sam, Pvt., C.E.
SANDERS, C. M., Jr., Lt., Signal Corps.
SANDFORT, J. F., Capt., 303 F.A. Bn.
SATTERLEE, H. A., Capt., Ordnance.
SAURWEIN, G. K., Major, Ordnance.
SCHNEEBERG, F. H., Sgt., Q.M.C.
SCHLICK, P. F., Col. C. A.
SCHROEDER, W. R., Pvt., 345th Infantry.
SEMEL, Edward, Pfc., 442nd Fighter Sqdn., Air Corps.
SHARP, J. R., Major, C.E.
SHEARER, W. A., Jr., 2nd Lt., C.E.
SHELL, J. D., Lt., C.E.
SLOANE. D. J., 56th General Hospital.
SMITH, W. P., Jr., Pfc. Engrs., Special Service Regt.
SNYDER, E. F., Capt., C.E.
SNYDER, E. J., Officer Candidate Reg't., C.E.
SOBEL, Frank, Pvt., Co. A, 101 M.B. Bn.
SOMMERFIELD, S. S., Pvt., Co. B.
SPENCE, R. A., Capt., Ordnance.
STENGEL, F. J., 1st Lt., Engrs. Bn.
STERNER, D. S., Capt., 282nd Q.M.C.
STEVENS, E. K., Capt., Liaison Officer.
STEVENS, K. M., Capt., C.A., 108th AA Gun Bn.
STROTHER, W. E., Capt., C.E.
SUTCH, H. C., Capt., Umatilla Ordnance Depot.

TICHENER, L. R., Jr., Lt., Range Officer.
TRAYNOR, H. S., Capt., C.E.
TUTHILL, A. F., 2nd Lt., Air Corps.

[1]Compiled as of October 15, 1944.

VAN NOUHUYS, H. C., 1st Lt., Signal Corps.
VINSON, N. L., 1st Lt., C.E.

WANGSGAARD, Dee, 1st Lt., N.M.B. A.U.S.
WARREN, R. M., Lt., Air Corps.
WATSON, G. M., Lt., G.H.D. of H.D.C.
WEATHERBY, E. P., Jr., Major, Air Corps.
WEAVER, J. v. O., Lt.-Col., Air Corps.
WEBSTER, Warren, Jr., Major, Ordnance.
WERNER, P. H., Capt., Signal Corps.
WILLIAMS, H. E., Pfc., Air Transport Section.
WILLS, F. W., Lt., 5th Airforce Flying Trng. Det.
WILSON, W. E., Lt.-Col., S.W.T.C.
WOLIN, Milton, A/C, Air Corps.

ZEIGLER, D. D., Lt., Air Corps.
ZINK, D. E., Lt-.Col., G.S.C., 1st Arm'd. Corps.

U. S. Navy

AKERS, G. W., Capt., U.S. Navy Yard.
ANDERSON, D. B., Lt. (jg), USNR.
ANDREWS, W. G., Mach. A-V (S), USNR.
ARENBERG, M. K., Lt.-Comdr., USNR.
ARVIDSON, E. R., Lt. (jg), USNR.
ASH, R. S., Lt. (jg), USNR.
AUSTIN, W. H., Lt. (jg), USNR.

BABER, H. L., Jr., Lt., U.S.S. Cushing
BAKER, H. L., Jr., Lt. (jg), USNR.
BAKER, R. H., Comdr., USNR.
BASTEDO, G. R., Ensign, USNR.
BENSINGER, Mark, Lt. (jg), USNR.
BIBLE, H. U., Lt. (jg), USNR.
BLAIR, D. W., Cpl., USMCR.
BOUILLON, Lincoln, Lt., 92nd M.C.B., USNR.
BOYD, S. W., Lt., USNR.
BRAUN, C. R., Jr., Midshipman, USNR.
BRISSENDEN, C. W., Lt., USNR.
BULL, Frederick W., Lt., USNR.
BURGES, J. H., RT 3/c.
BURTON, W. R., Warrant Officer, USNR.

CAMPBELL, R. P., Ensign, USNR.
CARTER, J. H., Lt., USNR.
CARY, E. B., Comdr. (CEC), USNR.
CHAPMAN, W. A., Jr., Lt-Comdr., USNR.
CHILDS, L. A., Lt., E-V (S), USNR.
CHIPMAN, E. E., Jr., Ensign, U.S.S. Litchfield.
COOPERMAN, E. S., S/2c, ABHTU, NAS.
COVER, R. R., Warrant Officer, E-V (S), USNR.
CURLEY, E. I., Lt., USNR.

DADDARIO, F. T., Ensign, USNR.
DANOWITZ, C. J., Ensign, USNR.
DAVIDSON, J. C., Lt., USNR.
DAVIS, Charles, Chief Petty Officer, USNR (Seabees).
DEAN, F. J., Jr., Lt. (jg), USNR.
DOVENER, R. F., Lt., USNR.
DRIEMEYER, F. C., Lt. (jg), USNR.

EGGERS, W. K., Lt. (jg), USNR.
EUTSLER, E. E., Jr., Lt., USNR.
EVANS, R. W., Lt.-Comdr. (CEC)-V (S), USNR.
EVERETTS, John, Jr., Lt. O-V (P), USNR.

FLORETH, J. J., Lt. (jg), USNR.
FLY, E. P., Hq. Co. 80th, USNCB.
FORBES, H. B., Jr., Lt. (jg), USNR.
FULLER, R. A., Lt.-Comdr., USNR.
FULLMAN, J. B., Ensign, USNR.

GODFREY, J. E., USNR.
GREGG, S. L., Lt.-Comdr., USNR.
GRIEST, K. C., Warrant Officer (CEC), USNR.
GRIFFIN, C. J., Lt. (jg), USNR.
GRIFFITH, H. T., Lt., USNR.

HARRIGAN, E. R., Lt., USNR.
HART, J. H., Lt., USNR.
HERMAN, N. B., Lt. (jg), USNR.
HERO, G. A., Jr., Lt.-Comdr., USNR.
HERRE, H. A., Lt. (jg), USNR.
HERTZLER, J. R., Lt., USNR.
HOLDEN, R. G., Lt., USNR.
HOLLAND, R. G., Lt., USNR.
HOLLAND, W. T., Lt. (jg), USNR.
HOUGHTEN, F. C., Comdr., USNR.
HUGHES, Charles, Lt. C.E.C., USNR.

IVERSON, H. R., Lt. (jg) D-V (S), USNR.

JOHNSTON, R. M., Lt. (jg), USNR.
JORDY, J. J., Lt., USNR.

KAHN, C. R., Jr., Lt., USNR.
KAYSER, P. G., Ensign USNR.
KEYES, M. W., Lt. (jg), USNR.
KILLIAN, W. J., Lt., USNR.
KLINK, E. J., Ensign U.S.S. Tennessee.
KOLASA, M. J., Ensign, E-V (S), USNR.
KOLB, R. P., Lt.-Comdr., USNR.
KUNEN, H. K., Ensign, USNR.

LADD, David, Lt.-Comdr., USNR.
LANDAUER, L. L., Lt.-Comdr. (CEC), USNR.
LANGE, F. F., Lt., USNR.
LEINBERGER, R.J.P., USNTC, Co. 1554.
LEVINE, L. J., Ensign, USNR.
LEVITT, L. L., Lt., USNR.
LEWIS, G. V., Pvt., Engrg. Bn., USMC.
LIEBLICH, Murray, Lt. (jg), USNR.
LOCKE, R. A., Lt.-Comdr., USNR.
LONG, E. J., Jr., Ensign (E-US), USNR.
LOUGHRAN, P. H., Jr., Ensign, USNR.
LYFORD, R. G., Ensign, USNR.
LYON, D. M., Pfc., USMC.

MABLEY, L. C., Lt., USNR.
MATHEKA, C. R., U.S.S. Tattnall.
MATTHIES, L. A., Ensign, USNR.
MAY, M. F., Lt., USNR.
MCCORMICK, G. W., Jr., 1st Lt., USMC.
MCDOWELL, H. L., Ensign, USNR.
MELTON, R. D., C.M. 1/c.
MILLARD, J. W., Lt., Organized Reserve.
MINOR, J. E., Ensign, USNR.
MITCHELL, A. E., Lt. (jg), USNR.
MITCHELL, A. J., Lt. (jg), USNR.
MORSE, L. S., Jr., Lt. (jg), USNR.

NOTTBERG, Henry, Jr., Seabees.
NOYES, R. R., Ensign (AUS), USNR.
PAETZ, G. A., Lt. (jg), USNR
PAINE, H. A., Ensign, USNR
PARKINSON, J. S., Lt.-Comdr., USNR.
PELLER, Leonard, Lt. (jg), USNR.
PORTER, N. E., Ensign, USNR.
POTTER, J. R., Lt., USNR.
POWERS, N. E., Ensign, USNR.

QUEER, E. R., Lt.-Comdr., USNR.

RAINSON, S. J., 2/c Machinist Mate.
RAISLER, R. K., CASU 22.
RAY, G. E., Elect. Mate 2/c, USCG.
REED, W. H., III, Lt. (jg), USNR.
RILEY, J. N., Lt., E-V (S), USNR.
RODEE, E. J., Lt., USNR.
ROGERS, C. S., Lt. (jg), USNR.

SCHECHTER, J. E., Lt. (jg), USNTS.
SGAMBATI, A. P., USNR.
SHAPIRO, C. A., Lt., USNR.
SIMPSON, R. L., Lt. (jg), USNR.
SMITH, C. F., Jr., Lt. (jg), USNR.
SPITZLEY, J. H., S. 2/c.
STACEY, A. E., Jr., Capt., USNR.
STEEL, R. J., Lt., USNR.
STERNE, C. M., Lt.-Comdr., USNR.
STOKES, T. A., Lt. (jg), USNR.
SULLIVAN, T. J., Ensign, USNR.

TIMMIS, W. W., Lt.-Comdr., USNR.
TRACY, W. E., Lt. (jg), USNR.
TURNER, J. P., Jr., Lt. (jg), USNR.

URDAHL, T. H., Comdr., E-V (S), USNR.

VAN ALSBURG, J. H., Lt., USNR.
VERVOORT, E. L., Lt. (jg), USNR.
VETLESEN, G. U., Lt.-Comdr., USNR

WALDEN, H. K., C.S.F., USNR.
WESTPHAL, N. E., Lt., U.S.S. Canberra, USNR.
WIDDOWFIELD, A. S., Lt., USNR.
WILDMAN, E. L., Lt. (jg), USNR.
WILLIAMS, G. E., A/S, USNCTC.
WILLIAMS, F. H., Lt. (jg), USNR.
WILSON, A. M., Ensign, USNR.
WORKMAN, A. E., Lt. (jg), USNR.
WYLD, R. G., Lt., USNR.

YOUNGER, J. R., Sp. 3/c (T), USNR.

ZINTEL, G. V., Lt. (jg), USNR.
ZUROW, W. A., Ensign, USNR.
ZYNDA, John R., Ensign, USNR.

Rank and Branch of Service Unknown

BATES, J. H.
BLUM, R. J., JR.
BRANIFF, P. R.
BREYER, Frederick.
DILLENDER, E. A.
FAXON, H. C.
HOLMES, Arthur D.
HOLMES, D. W.
HOLZER, R. J., JR.
HONEY, R. L.
HUFF, J. M.
JOHNSON, L. O.
LINK, C. H.
MELTON, H. E.
ORMISTON, J. B.
RAMSEUR, V. D., Jr.
RODEFFER, E. W.
ROPER, R. F.
ROSAS, M. L.
ROSS, D. S.
SIEGEL, Daniel E.
TUTSCH, R. J.

VOLK, G. H.
VON ROSENBERG, P. C.
WESTOVER, Wendell.
WRIGHT, N. S., JR.

Members in Allied Service

ALLSOP, R. P.*
ARMOUR, E. G., RCAF.
BALLANTYNE, G. L., Instructor, RCAF.
BARRETT, C. M., Capt., Canadian Army.
BELLMAN, J. V., Ch. Petty Officer.
BISHOP, J. W., Lt.-Col., Canadian Active Service Forces.
BODMER, Emmanuel, Lt., Air Force.
BOWERMAN, E. L., Fl/Lt., RCAF.
BUTT, Roderick E. W.*
DANIEL, W. E., 2nd Lt., Royal Artillery
DION, A. N., F/O, RCAF.
DOWLER, E. A., Lt., Canadian Army, RCOE.
FOX, J. H., Lt.-Col., Ordnance Co., Canadian Army.
HILL, H. G., Sub. Lt., Engr., RCNVR.
HOLE, Kenneth, Fl/Lt.
JOHNS, C. F., Sqdn. Leader, RCAF.
KITCHEN, W. H. J., Elec'l Lt., RCNVR.
LABONNE, Henri, Capt., Canadian Army.
MARRINER, J. M. S., Lt.-Comdr., RCNR.
MACLACHLAN, V. D., Fl/Lt., RCNVR.
NORFOLK, L. W., Lt.-Col., H. M. Forces, Royal Engrs.
MCDONALD, IVAN.*
NEVIN, J. F., Capt., Hq., Eastern Command.
NOVOLANSKY, S. I., Fl/Sgt., RCAF.
PENNOCK, W. B., Lt.-Col., RCE, 5th Canadian Div.
POUGHER, B. R. E., Sgt., 110 (el) A. T. Coy R. E.
PRICE, E. H., Capt., Q.M.C., RCE.
PRYKE, J. K. M., Capt., Royal Army Ordnance Corps.
RICHARDSON, R. D., Sgt., Bombardier, Royal Regt. Artillery.
ROBINSON, Jack A.*
SMITH, G. E., Major, RCE.
WILKINSON, Arthur, Fl/Lt., RCAF.
WOOD, A. W., Fl/Lt., RCAF.

*Rank and Branch of Service unknown

Killed in Action

FOSTER, Phil H., Wing Commander in RAF (Flin Flon, Manitoba, Canada).

TEMPLE, Harold L., Flying Officer, RAF (London, England).

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CAPTAIN PRYKE RETURNS

A pleasant surprise for his family and friends was the arrival in the United States of Captain J. K. M. Pryke, who is now on duty in Detroit.

At the start of the war he was commissioned in the Royal Electrical and Mechanical Engineers and soon saw active field service.

Soon after his arrival in New York, he was invited to tell some of the details of his experiences as a German prisoner of war and he gave the following statement:

I was captured by the Germans on Crete on June 1, 1941. After capture we marched about 75 miles from the south to the north side of the island and we were then put in a temporary P.O.W. cage for ten days, and then were flown back to Athens. From here we went by train to Salonika, and at one point in the journey, as the railroad had been demolished, we had to march twenty-five miles across the mountains.

At Salonika we were kept for six weeks in an old Greek barracks which had been turned into a temporary prison camp. During all this period, food was very short, and most of us only had in the way of clothes, the tropical kits in which we had been captured. Conditions in the barracks were very bad as washing and sanitary facilities were of the crudest and quite inadequate. About the end of July we were sent back to Germany. The railroad journey occupied nine days, and we traveled in small freight cars, thirty-five of us in each car. Not a very pleasant journey as many people were suffering from dysentery.

The first proper prison camp in Germany was near Lübeck. Accommodation was not too bad, but unfortunately we got no Red Cross supplies, and had to live entirely on the German rations. We also saw a great deal of the night air raids then being carried out by the R.A.F.

Capt. J. K. M. Pryke

In October 1941, we were moved to a large camp near Munster and here we began to get Red Cross food parcels and clothing, by this time very much needed. Unfortunately, accommodation was poor as we were living in badly constructed sectional wooden huts with very little fuel for heating, and all washing and sanitary facilities were external, the latter again being of very elementary type. There were about 2400 British Army and about 400 R.A.F. officers in this camp. Escaping attempts became so numerous that eventually the camp was disbanded, and we were dispersed to various smaller camps; the majority of prisoners going to one in Bavaria, where accommodations and general conditions were a little better.

After about a year, in July 1943, a small party of us moved again to a camp near Kassell. This had been a large girls' school before the war, and relatively speaking was the most comfortable camp in Germany. Unfortunately the only exercise space was the school playground, so eventually we were allowed to go out for walks, three per week allowed. I was here until I was repatriated except for an interlude in hospital. I had had a great deal of internal trouble whilst a prisoner and eventually passed the Mixed Medical Commission (German-Swiss) for repatriation, coming home at the end of May of this year.

Generally speaking, conditions in the prison camps may be said to have improved over the last year. The Red Cross food parcels arrive regularly and are distributed one to each prisoner weekly. They form the bulk of the food received and with the small German rations provide enough to live on, although, of course, the standard of living cannot be compared in any way with that in this country or England.

After the food parcels, the next most important thing in P.O.W. life is mail and the arrival and distribution of each batch is most eagerly awaited. Athletics and games are very important, too, and most camps have reasonable sports equipment and facilities. Educational arrangements are well developed and the examinations of most of the technical institutions can be taken through the Red Cross. Text books are available in many subjects and most camps have good libraries. No Allied magazines of any sort are allowed, although sometimes a few technical publications can be had through the Y.M.C.A. or similar bodies.

Morale is very high and great unity exists between prisoners of the various Allied nations. In many cases the camp leaders have taken a very firm line against attempted discrimination by the Germans between American, British and Empire personnel.

In conclusion, too high a tribute cannot be paid to the wonderful work of the Red Cross. Besides the food parcels, which literally keep prisoners alive, they send clothing, medical supplies, books and a host of other necessities. Also the Y.M.C.A. and the International Students European Relief Fund do an excellent job in providing sports and educational supplies, etc., and are generally most helpful. Representatives of all these bodies visit the camps periodically as do the Swiss who act as Protecting Power for Britain and America.

LUND JOINS SEEGER

Appointment of C. E. Lund as Director of Research for the Seeger Refrigerator Co., St. Paul, Minn., effective October 1, was announced by W. G. Seeger.

Mr. Lund has been in the refrigeration and air conditioning field since graduating from the University of Minnesota as a Bachelor of Mechanical Engineering and Master of Science in Mechanical Engineering.

Recently he has served as Associate Professor and Assistant Director of the Engineering Experiment Station of the University of Minnesota, where he worked in cooperation with Prof. F. B. Rowley, Director of the Engineering Experiment Station, and Dr. R. C. Jordan, Associate Professor and Director of Industrial Engineering Laboratories. Together Mr. Lund and Dr. Jordan developed the refrigeration laboratory of the University of Minnesota and built the course in applied refrigeration which is sponsored by the U. S. Office of Education under the Engineering Science Management War Training Program.

In 1937 he was Research Engineer of the University of Minnesota in charge of Cooperative Industrial Research under Professor Rowley, specializing in the study of moisture and vapor transmission through insulation. Together Professor Rowley and Mr. Lund wrote a series of papers dealing with this subject and much of the data were presented at meetings of the ASHVE.

After graduating from the University of Minnesota Mr. Lund

C. E. Lund

worked for the City of Minneapolis under the Building Inspector's office on heating, ventilating and air conditioning. In 1944 he was Assistant Professor and Assistant Director of the Engineering Experiment Station of the University of Minnesota.

He is a member of the *American Society for the Advancement of Science*, the *American Society of Refrigerating Engineers*, and the American Society of Heating and Ventilating Engineers, as well as Pi Tau Sigma and Sigma Xi.

LESTER SEELIG DIES IN CHICAGO

In the death on October 12 of Lester Seelig, Illinois Chapter lost one of its staunch members. A few months ago Mr. Seelig established his office in Chicago as mechanical engineer, specializing in dust and fume systems, dehydration drying and air conditioning, after spending about two years in Detroit with the U. S. Rubber Co.

Mr. Seelig was born in Chicago on November 25, 1895, and was graduated with a B. S. in mechanical engineering from the University of Illinois. In 1914 and 1916 he was a draftsman for the American Carton Sealing Machine Co., and for the next three years was associated with Armour Co., making power plant layouts and designing refrigerating systems. In 1922-30 he was a mechanical engineer for Drying Systems, Inc., in Chicago and New York. For the next few years he had his own office as a consulting engineer, and in 1933 he became mechanical engineer for the Museum of Science and Industry in Chicago, and served as head of the engineering department and as chief engineer until 1942.

The Officers and Council of the American Society of Heating and Ventilating Engineers extend their sincere sympathy to his family in their bereavement.

SUMMARY OF LOCAL CHAPTER MEETINGS

Chapter	Meeting Date	Subject	Speakers	Other Features	Attendance	Attendance Ratio*
Atlanta	Oct. 9	Frontiers of the Future. Post Mark: U. S. A. Your Town: A Story of America	W. R. Darragh, Nat'l Assoc. of Manufacturers (presented films)	Nominating Committee appointed consisting of Messrs. Koch, Templin, Kent and Tucker		
Central Ohio	Sept. 19	Activities of Society Functions of a Chapter	A. V. Hutchinson, Secretary of ASHVE H. E. Sproull, Chairman, Chapter Relations Committee.	Election of First Officers: Pres. J. D. Slemmons, Vice-Pres. A. I. Brown, Treas. H. R. Allonier, Sec'y A. W. Williams	30	0.80
Golden Gate	Sept. 6	What the Architect Expects of the Consulting Engineer	John S. Bolles, Head, California State Assoc. of Architects	Treasurer's Report and Report of Program Committee were presented	46	0.50
Iowa	Oct. 9	Heating and Air Conditioning Work in Latin America	A. J. Offner, 2nd Vice-Pres. of ASHVE, New York, N. Y.	M. L. Todd reported on work of State Building Code Committee	17	

Chapter	Meeting Date	Subject	Speakers	Other Features	Attendance	Attendance Ratio*
Kansas City	Oct. 2	The Future of Electronics in Air Conditioning	J. E. Haines, Vice-Pres., Minneapolis Honeywell Regulator Co., Minneapolis, Minn.	Three colored films on basic fundamentals of electricity	73	0.91
		War Chest Drive.	Searcy Ridge			
		National Fuel Efficiency Program	Melvin Hatcher, Dir., Water Dept., Kansas City			
	Sept. 20	The Engineer in the Post War World	Dr. C.-E. A. Winslow, 1st Vice-Pres., ASHVE, New Haven, Conn.	Discussion	48	0.66
Minnesota	Sept. 11	Two one-reel Motion Pictures	Charles Carroll	New Constitution and By-Laws Accepted	30	0.34
North Texas	Sept. 18	The Engineer in the Post War World	Dr. C.-E. A. Winslow, 1st Vice-Pres., ASHVE	Discussion	40	0.82
Oklahoma	Sept. 19	The Air Cooled Human Body	Dr. C.-E. A. Winslow, 1st Vice-Pres. ASHVE	Interesting Discussion followed	40	4.0
Ontario	Oct. 2	New Ideas in Coal Utilization	E. R. Kaiser, Asst. Dir. of Research, Bituminous Coal Research, Inc., Pittsburgh, Pa.	Life Membership Certificate to Melvern F. Thomas	103	0.40
Pittsburgh	Oct. 9	Psychology and the Thermostat	F. C. McIntosh, Br. Mgr., Johnson Service Co.	E. C. Smyers reported on membership	35	0.53
St. Louis	Sept. 5	Application of Refrigeration for Low Temperatures	E. B. Cover, Application Engr., General Electric Co.	Announcement was made that R. H. Kremer was elected Pres. of Engineers' Club and Pres. of A.E.S.	32	0.50
Western Michigan	Oct. 9	Chapter 5 of ASHVE GUIDE discussed		C. H. Pesterfield reported on chapter delegates' meeting at Semi-Annual Meeting	44	1.0

*The attendance ratios shown represent the meeting attendance divided by the Chapter membership. These will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by other local chapters and may be helpful in deciding on subjects for other chapter meetings.

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 69 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by Nov. 15, 1944, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
AMUNDSON, CARL H., Sales Engr., Herman Nelson Corp., Milwaukee, Wis.	C. W. Miller Rex Vernon	E. W. Gifford M. W. Bishop
BARNES, CHARLES A., Engr., E. G. Sheet Metal Works, Atlanta, Ga.	W. J. McKinney C. L. Templin	L. L. Barnes Leo Sudderth, Jr.
BEARG, MILTON J., Air Cond. Design Engr., Ansco, Binghamton, N. Y.	W. L. Fleisher M. F. Rather	M. J. Friedlieb R. A. Wasson
BERKELEY, C. D., Design Engr., U. S. Army Engineers, Seattle, Wash.	Roy Conrad C. W. May	C. W. Finn R. E. LeRiche
BERRY, PATRICK M., Secy. & Treas., Standard Asbestos Manufacturing Co., Cleveland, Ohio.	J. E. Wilhelm D. L. Taze	W. M. Rowe R. T. Southmayd
BISHOP, ALBERT H., Elec. Foreman, Abasand Oils Ltd., Fort McMurray, Alberta, Canada.	*S. S. Colle *E. E. Brown	*P. D. P. Hamilton *P. F. Peele
BLOCH, LEONARD L., Owner, New York, N. Y.	*L. Emerson *Robert Jones, Jr.	*Olaf Forsberg *Leo Alter
BODWELL, GEORGE B., Contract Mgr., The Philip Carey Manufacturing Co., Cleveland, Ohio.	J. E. Wilhelm D. L. Taze	R. T. Southmayd G. B. Priester
BOWERS, CHARLES L., Mgr., E. G. Sheet Metal Works, Hapeville, Ga.	W. J. McKinney C. L. Templin	L. L. Barnes Leo Sudderth, Jr.
BROOKE, BERNARD B., Dist. Vent. Engr., The General Electric Co., Ltd., Kingsway, Cardiff, England.	R. H. Davies B. B. Daly	E. K. Campbell D. M. Allen
BROWN, RICHARD C., Mgr., Campbell Elsey & Co., Salt Lake City, Utah.	H. G. Richardson E. V. Gritton	C. E. Murdock J. L. Ashton
BURNS, ROBERT O., 1st Lt., Corps of Engineers, New Guinea.	A. F. Avera J. A. Ray	D. W. Harrington E. T. Gessell
CALONGNE, HENRY J., JR., Mech. Engr., Emile M. Babst Co., New Orleans, La.	W. H. Grant, Jr. L. V. Cressy	G. E. May J. S. Burke
CARLETON, HERBERT G., Assoc. Mech. Engr., Maritime Commission, Washington, D. C.	J. W. Markert J. H. Fogg	R. E. von Otto F. A. Leser
CASE, DONALD P., Engr., W. C. Wiedenmann & Son, Kansas City, Mo.	L. P. Heaven W. A. Wiedenmann	D. M. Allen E. K. Campbell
CONROY, W. T., Htg. & Plbg. Contr., Kansas City, Mo.	Carl Clegg C. L. McMichael	M. M. Rivard R. B. Mason
DAPPER, M. J., Owner, Tacoma, Wash.	*C. P. Dougherty *Oscar Mertz	*G. D. Fay *H. Wezenberg
DAVENPORT, L. B., Chief Engr., Air Conditioning Company of Southern California, Los Angeles, Calif.	I. P. Fulmor A. J. Hess	H. B. Lauer Harrold English
DODD, JOHN A., Owner, John A. Dodd Co., Atlanta, Ga.	C. L. Templin I. B. Kagey	C. B. Smoot L. L. Barnes
DROBA, CHARLES R., Sales Engr., Ehret Magnesia Manufacturing Co., Washington, D. C.	Laurence Shuman J. H. Hanlein	R. Skagerberg C. R. Kidd
DUNBAR, LEON W., Dist. Mgr., Clarage Fan Co., Cleveland, Ohio.	W. A. Evans W. G. Schlichting	H. W. Wolters C. R. McConner
DYER, ALVIN R., Mgr., Htg. & Air Cond. Dept., Utah Builders Supply Co., Salt Lake City, Utah.	H. G. Richardson E. V. Gritton	C. E. Murdock J. L. Ashton
ENGLISH, A. T., Pres. & Gen. Mgr., Columbus Air Conditioning Corp., Columbus, Ohio. (*Advancement*)	T. R. Walker Howard Allonier	W. M. Myler, Jr. J. D. Slemmons
FERRARA, ANTHONY L., Partner, Standard Heating Co., Minneapolis, Minn.	F. W. Legler A. J. Huch	L. K. Reisberg Lyman Gross
GALABA, ALEXANDER, Chief Engr., Morrison Products, Inc., Cleveland, Ohio.	K. T. Davis R. M. Conner	H. F. Curtis J. F. Platz
GARNETT, WILLIAM, Mech. Engr., Frankfort Arsenal, Philadelphia, Pa.	E. J. Berlet, Jr. E. F. Roberts, Jr.	H. H. Erickson M. F. Blankin
GAY, CLARENCE E., JR., Asst. Engr., E. K. Campbell Heating Co., Kansas City, Mo.	E. K. Campbell D. M. Allen	L. P. Heaven M. M. Rivard
GRANDSTAFF, CLARENCE L., Engr., The C. A. Olsen Manufacturing Co., Elyria, Ohio.	E. R. Downe J. E. Maynard	D. L. Taze W. M. Rowe
GREGORY, PAUL E., Sales Engr., Horne-Wilson, Inc., Atlanta, Ga.	W. J. McKinney C. L. Templin	L. L. Barnes S. L. North
HELLAND, ALBERT E., Engrg. Officer, U. S. Navy, Fleet P. O., N. Y.	J. H. Seippel H. A. Maccubbin	C. W. Stewart E. N. Sanbern
HILL, ARTHUR M., Assoc. Prof., Tulane University, New Orleans, La.	G. C. Kerr G. E. May	J. M. Guillory J. S. Burke
INCE, FRANK E., Mech. Engr., Giffels & Vallet, Inc., Detroit, Mich.	C. F. Boester R. S. M. Wilde	E. F. Hyde G. H. Whybrew
JARRETT, R. F., Tech. Dir., Flexaire Heaters, Ltd., London, England.	L. C. Watts G. N. Haden	*R. J. Fletcher *W. H. V. Clark
KENNEY, DANIEL J., Chief, Fuels & Utilities Unit, Boston Ordnance Dist., Boston, Mass.	R. D. Tyler John Bonner	C. T. Flint Carl Larson
LANDERS, DAVID N., Owner, Landers Plumbing & Heating Co., Atlanta, Ga.	W. J. McKinney C. L. Templin	L. L. Barnes Leo Sudderth, Jr.
LEE, BURTON H., Mance Air Conditioning Corp., New York, N. Y. (*Advancement*)	M. F. Rather Joe Wheeler, Jr.	H. J. Ryan C. R. Hiers
LEVY, ROBERT, Sr. Mech. Engr., Federal Public Housing Authority, Washington, D. C.	Laurence Shuman C. R. Kidd	R. Skagerberg George Underwood
LIX-KLETT, LUIS, Chief Engr. & Dir., Carrier Lix-Klett S. A., Buenos Aires, Argentina, S. A.	Americo Silvera W. H. Carrier	N. E. Sheldon Margaret Ingels
LONG, EUGENE L., Dist. Repr., The Avery Engineering Co., Columbus, Ohio.	L. T. Avery J. E. Wilhelm	Dennis Boggs J. D. Slemmons

MacDonald, James, Dist. Mgr., Reid Hayden, Inc., Charlotte, N. C.

Manna, A. F., Designer, Wilbur Watson & Assoc., Cleveland, Ohio.

Matthews, Carl R., Service & Installation Mgr., Minneapolis-Honeywell Regulator Co., Lakewood, Ohio.

Maycock, Ambrose A., Mgr., A. A. Maycock Co., Salt Lake City, Utah.

McCann, Stanford C., Owner, S. C. McCann Co., Kansas City, Mo.

Miller, H. Deane, Mgr., Air Cond. & Comm'l Refrig. Dept., General Electric Supply Corp., Salt Lake City, Utah.

Mitchell, J. S., Indus. Mgr., Crane Co., Memphis, Tenn.

Moore, R. S., Precipitron Engr., Westinghouse Electric & Manufacturing Co., Chicago, Ill.

Nordin, John G., Service Engr., Southern California Gas Co., Los Angeles, Calif.

Pangborn, C. A., Mech. Engr., Seattle, Wash.

Parizeault, J. A. R., Supt., J. & C. Brunet, Ltd., Montreal, Que., Canada.

Quade, Harry, Jr., Gen. Mgr., William Schupp & Co., Minneapolis, Minn.

Raider, George K., Designer-Engr., Pyle National Co., Chicago, Ill.

Reed, George G., Htg. & Vent. Engr., Cleveland, Ohio.

Richeda, Alfred, Supt., The Lang Co., Salt Lake City, Utah.

Rodkin, David B., Ensign, Air Cond. Sect., Navy Dept., Washington, D. C.

Sayler, William H., Engr., Specialty Sales Co., Salt Lake City, Utah.

Scott, Richard P., Comm'l Sales Mgr., Bard, Inc., Columbus, Ohio.

Stamberger, Robert F., Supt., The Stamberger Co., Cleveland Heights, Ohio.

Streater, Walter A., Sales Repr., Modine Manufacturing Co., Atlanta, Ga.

Taylor, C. Ridgway, Rose Brothers Co., Inc., Arlington, Va.

Terrance, E. H., Mgr., Canadian Sirocco Co., Montreal, Que., Canada.

Towner, Charles E., Testing Engr., Crane Co., Chicago, Ill.

Underwood, John L., Jr., Owner, John L. Underwood Co., Atlanta, Ga.

Vincent, H. B., Mgr., Product Development, Owens-Illinois Glass Co., Ottawa Hills, Ohio.

Waldsmith, Earl C., Sales Engr., Hughes Machinery Co., Kansas City, Mo.

Wilde, Dale R., Engr., Williams & Richardson, Salt Lake City, Utah.

Wilson, George H., Sr. Engr., Atlas Electric Devices Co., Hannibal, Mo.

Wilson, Leonard M., Plant Engr., Hoosier Cardinal Corp., Evansville, Ind.

Wright, C. P., Mgr., C. P. Wright & Co., Cleveland, Ohio.

Karl Selden, Jr. R. D. Van Sisk	C. W. Hallenbeck E. S. DeWitt	
C. F. Eveleth L. H. Pogalies	Anthony Kazlouskas R. A. Wilson	
J. E. Wilhelm D. L. Taze	R. T. Southmayd L. T. Avery	
H. G. Richardson E. V. Gritton	R. H. East C. E. Ferguson	
R. B. Mason W. L. Cassell	P. C. Leffel F. F. Dodds	
H. G. Richardson E. V. Gritton	E. D. Smith J. L. Ashton	
E. E. Scott R. H. Hoshall	T. J. O'Brien W. E. Thorpe	
K. C. Richmond A. O. May	J. J. Aeberly V. L. Wesby	
H. Cumnock O. W. Ott	*A. Hanson M. C. McKenzie, Jr	
R. D. Morse R. E. LeRiche	D. C. Griffin E. L. Weber	
Leo Garneau F. A. Hamlet	T. H. Worthington R. O. Boland	
W. F. Uhl E. F. Bell	R. E. Gorgen L. C. Gross	
M. J. Stevenson R. O. Nelson	C. H. Bevington S. R. Lewis	
J. E. Wilhelm L. T. Avery	G. B. Priester R. H. Cutting	
E. D. Smith H. G. Richardson	E. V. Gritton C. E. Murdock	
T. H. Urdahl John Everetts, Jr.	E. R. Queer C. M. Hamblin	
H. G. Richardson E. V. Gritton	C. E. Murdock J. L. Ashton	
J. D. Slemmons R. B. Breneman	D. H. Wyatt I. B. Spencer	
J. P. Jones R. L. Byers	J. E. Wilhelm R. H. Cutting	
M. W. Wise W. J. McKinney	C. L. Templin L. L. Barnes	
T. H. Urdahl F. A. Leser	H. H. Hill W. C. Jones	
A. M. Peart S. W. Salter	A. B. Madden Leo Garneau	
M. W. McRae E. P. Heckel	C. J. Stermer J. D. Pierce	
W. J. McKinney C. L. Templin	I. B. Kagey L. L. Barnes	
R. A. Miller *U. E. Bowes	*C. E. Ford Axel Marin	
R. B. Mason L. P. Heaven	W. L. Cassell Carl Clegg	
E. V. Gritton H. G. Richardson	C. E. Murdock J. L. Ashton	
C. M. Burnam, Jr. F. P. Keeney	C. E. Price *A. Well	
W. C. Bevington G. B. Supple	C. H. Hagedon S. E. Fenstermaker	
J. E. Wilhelm D. L. Taze	R. T. Southmayd E. J. Sable	

*Non-Member.

Candidates Elected

In the past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBER

Linsenmeyer, F. J., Director of Research, Great Lakes Steel Corp., Detroit, Mich. (*Reinstatement*)

Marshall, Harold W., Mech. Engr., T. H. Buell and Co., Denver, Colo.

ASSOCIATES

Arndt, Heinrich W., Augusta, Ga. (*Reinstatement*)

Lainson, Harry A., Jr., Secy-Treas., Jaden Manufacturing Co., Hastings, Nebr.

Price, Frank E., Vice-Pres., Peerless Colorado Co., Denver, Colo.

Seepe, Paul E., Minneapolis-Honeywell Regulator Co., Atlanta, Ga. (*Reinstatement*)

Officers

President.....S. H. Downs
First Vice-President.....C.-E. A. Winslow
Second Vice-President.....Alfred J. Offner
Treasurer.....L. P. Saunders
Secretary.....A. V. Hutchinson
Technical Secretary.....Carl H. Flink

Council

S. H. Downs, *Chairman* C.-E. A. Winslow, *Vice-Chairman*

Three Years: C. M. Ashley, L. T. Avery, L. E. Seeley, G. D. Winans.

Two Years: J. F. Collins, Jr., James Holt, E. N. McDonnell, T. H. Urdahl.

One Year: W. A. Danielson, L. G. Miller, A. E. Stacey, Jr., B. M. Woods, M. F. Blankin, G. L. Tuve, *Ex-Officio.*

Council Committees

Executive—A. J. Offner, *Chairman;* E. N. McDonnell, A. E. Stacey, Jr.

Finance—B. M. Woods, *Chairman;* L. E. Seeley, T. H. Urdahl, L. P. Saunders, *Ex-Officio.*

Membership—M. F. Blankin, *Chairman;* J. F. Collins, Jr., G. D. Winans.

Meetings—C.-E. A. Winslow, *Chairman;* L. T. Avery, L. G. Miller.

Standards—L. P. Saunders, *Chairman;* C. M. Ashley, James Holt.

Advisory Council

M. F. Blankin, *Chairman;* Homer Addams, D. S. Boyden, W. H. Carrier, S. E. Dibble, W. H. Driscoll, E. O. Eastwood, W. L. Fleisher, H. P. Gant, F. E. Giesecke, E. Holt Gurney, L. A. Harding, H. M. Hart, C. V. Haynes, E. Vernon Hill, John Howatt, W. T. Jones, D. D. Kimball, G. L. Larson, S. R. Lewis, Thornton Lewis, J. F. McIntire, F. B. Rowley and A. C. Willard.

Nominating Committee

Chapter	Representative	Alternate
Atlanta	T. T. Tucker	I. B. Kagey
Cincinnati	G. V. Sutfin	H. A. Pillen
Connecticut	H. E. Adams	Stanley Hart
Delta	J. S. Burke	C. B. Gamble
Golden Gate	R. A. Folsom	C. E. Bentley
Illinois	E. M. Mittendorff	A. O. May
Indiana	G. B. Supple	J. G. Hayes
Iowa	C. W. Helstrom	W. W. Stuart
Kansas City	D. M. Allen	W. A. Russell
Manitoba	F. L. Chester	William Glass
Massachusetts	E. G. Carrier	R. T. Kern
Michigan	S. S. Sanford	W. H. Old
Minnesota	R. C. Jordan	F. B. Rowley
Montreal	T. H. Worthington	A. B. Madden
Nebraska	D. E. McCulley	B. G. Peterson
New York	R. A. Wasson	C. S. Koehler
North Carolina	Arvin Page	P. L. Guest, Jr.
North Texas	G. A. Linskie	E. T. Gessell
Northern Ohio	L. S. Ries	John James
Oklahoma	E. T. P. Ellingson	
Ontario	V. J. Jenkinson	W. C. Kelly
Oregon	E. C. Willey	
Pacific Northwest	M. N. Musgrave	J. D. Sparks
Philadelphia	H. B. Hedges	Edwin Elliot
Pittsburgh	T. F. Rockwell	E. H. Riesmeyer, Jr.
St. Louis	G. B. Rodenheiser	C. F. Boester
South Texas	J. A. Walsh	A. B. Banowsky
Southern California	Leo Hungerford	W. O. Stewart
Washington, D. C.	F. A. Leser	W. H. Littleford
Western Michigan	C. H. Pesterfield	J. W. Miller
Western New York	S. M. Quackenbush	S. W. Strouse
Wisconsin	A. S. Krenz	M. W. Bishop

Officers of Local Chapters

Atlanta: Organized, 1937. Headquarters, Atlanta, Ga. Meets, First Monday. President, M. M. Crout, 412 Houston St., N. E. Secretary, L. L. Barnes, 3995 N. Stratford Rd.

Central Ohio: Organized, 1944. Headquarters, Columbus, Ohio. President, J. D. Slemmons, 2 Fifteenth Ave., Columbus 1. Secretary, A. W. Williams, 5 E. Long St., Room 808, Columbus 15.

Cincinnati: Organized, 1932. Headquarters, Cincinnati, O. Meets, Second Tuesday. Honorary President, Capt. C. E. Hust. President, G. V. Sutfin, 1005-6 American Bldg., Cincinnati 2. Secretary, A. W. Edwards, 626 Broadway, Rm. 307, Cincinnati 2.

Connecticut: Organized, 1940. Headquarters, New Haven, Conn. President, L. A. Teasdale, 20 Ashmun St. Secretary, Winfield Roeder, 405 Temple St.

Delta: Organized, 1939. Headquarters, New Orleans, La. Meets, Second Tuesday. President, L. V. Cressy, 423 Baronne St., New Orleans 13. Secretary, J. S. Burke, 317 Baronne St., New Orleans 9.

Golden Gate: Organized, 1937. Headquarters, San Francisco, Calif. Meets, First Wednesday. President, C. L. Peterson, 2 Indian Rock Path, Berkeley. Secretary, James Gayner, 260 California St., San Francisco 11.

Illinois: Organized, 1906. Headquarters, Chicago, Ill. Meets, Second Monday. President, A. O. May, Room 925, 53 W. Jackson Blvd., Chicago 4. Secretary, C. M. Burnam, Jr., Room 1605, 6 N. Michigan Ave., Chicago 2.

Indiana: Organized, 1943. Headquarters, Indianapolis, Ind. Meets, Fourth Friday. President, W. C. Bevington, 730 Indiana Pythian Bldg. Secretary, C. W. Stewart, 1001 York St.

Iowa: Organized, 1940. Headquarters, Des Moines, Ia. Meets, Second Tuesday. President, W. W. Stuart, 417 9th St. Secretary, E. O. Olson, Iowa State College, Ames.

Kansas City: Organized, 1917. Headquarters, Kansas City, Mo. Meets, First Monday. President, D. M. Allen, 215 Pershing Rd., Kansas City 8. Secretary, R. E. Bade, 1102 Commerce Bldg.

Manitoba: Organized, 1935. Headquarters, Winnipeg, Man. Meets, Third Thursday. President, Einar Anderson, 152 Bannerman Ave. Secretary, F. T. Ball, 810 9th Ave., W., Calgary, Alta.

Massachusetts: Organized, 1912. Headquarters, Boston, Mass. Meets, Third Tuesday. President, D. M. Archer, 143 Federal St., Boston 10. Secretary, C. W. Larson, 184 Sycamore St., Roslindale.

Memphis: Headquarters, Memphis, Tenn. President, J. J. Nolan, 78 Washington Ave. Secretary, W. E. Thorpe, 78 Washington Ave.

Michigan: Organized, 1916. Headquarters, Detroit, Mich. Meets, First Monday after 10th of month. President, W. H. Old, 1761 Forest Ave. W., Detroit 8. Secretary, A. E. Knibb, 1003 Maryland Ave., Detroit 30.

Minnesota: Organized, 1918. Headquarters, Minneapolis, Minn. Meets, First Monday. President, F. W. Legler, 17 W. 28th St. Secretary, F. H. Schernbeck, 1057 10th Ave. S. E.

Montreal: Organized, 1936. Headquarters, Montreal, Que. Meets Third Monday. President, A. M. Peart, 637 Craig, W. Secretary, Leo Garneau, Room 832, Dominion Square Bldg.

Nebraska: Organized, 1940. Headquarters, Omaha. Meets, Second Tuesday. President, B. G. Peterson, 6235 Florence Blvd. Secretary, D. E. McCulley, 814 S. 14th St., Omaha 2.

New York: Organized, 1911. Headquarters, New York, N. Y. Meets, Third Monday. President, C. S. Koehler, 4374 Richardson Ave., New York 66. Secretary, Carl H. Flink, Room 3000, 51 Madison Ave., New York 10.

North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, F. E. P. Klages, 1034 Jefferson Standard Bldg., Greensboro. Secretary, W. L. Hunken, 707 Guilford Bldg., Greensboro

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, L. C. McClanahan, 603 Great National Life Bldg. Secretary, E. J. Stern, 701 Burt Bldg., Dallas 1.

Northern Ohio: Organized, 1916. Headquarters, Cleveland, O Meets, Second Monday. President, D. L. Taze, 1302 Swetland Bldg., Cleveland 15. Secretary, R. H. Cutting, 3795 Glenwood Rd., Cleveland Heights.

Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, E. T. P. Ellingson, 314 Savings Bldg., Oklahoma City 2. Secretary, G. T. Donceel, Oklahoma Natural Gas Co.

Ontario: Organized, 1922. Headquarters, Toronto, Ont. Meets, First Monday. President, A. S. Morgan, 156 Glenmanor Dr. Secretary, H. R. Roth, 57 Bloor St., W.

Oregon: Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, E. C. Willey, Oregon State College, Corvallis. Secretary, G. H. Risley, 516 S. W. Oak St., Portland 4.

Pacific Northwest: Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, M. N. Musgrave, 2019 Third Ave., Seattle 1. Secretary, J. D. Sparks, 7331 W. Green Lake Way, Seattle 3.

Philadelphia: Organized, 1916. Headquarters, Philadelphia, Pa. Meets, Second Thursday. President, A. C. Caldwell, 550 So. 48th St., Philadelphia 43. Secretary, J. O. Kirkbride, Fourth and Locust Sts., Philadelphia 6.

Pittsburgh: Organized, 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, T. F. Rockwell, Carnegie Institute of Technology, Schenley Park. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

Rocky Mountain: Headquarters, Denver, Colo. President, J. H. McCabe, 1730 Glenarm St. Secretary, F. L. Adams, P. O. Box 840, Denver 1.

St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, G. B. Rodenheiser, 4431 Finney Ave., St. Louis 13. Secretary, B. L. Evans, 571 Stratford Ave., University City.

South Texas: Organized, 1938. Headquarters, Houston, Texas. Meets, Third Friday. President, A. F. Barnes, 602 Kirby Bldg., Houston 2. Secretary, B. P. Fisher, Box 92, Houston 1.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Second Wednesday. President, Leo Hungerford, 3485 Wonderview Pl., Los Angeles 28. Secretary, Arthur Theobald, 336 North Foothill Rd., Beverly Hills, Calif.

Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, J. W. Markert, 8506 Garfield St., Bethesda, Md. Secretary, A. S. Gates, Jr., 111 County Rd., Kensington, Md.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, H. D. Bratt, 2259 Stafford Ave., S. W., Grand Rapids 7. Secretary, Frank Harbin, Jr., 181 West 21st St., Holland.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, S. W. Strouse, 493 Franklin St., Buffalo 2. Secretary, G. E. Adema, 39 W. Balcom St.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, L. J. Haus, 3880 N. Richards St., Milwaukee 1. Secretary, M. W. Bishop, 231 W. Wisconsin Ave., Milwaukee 3.